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SAFETY EVALUATION FOR THE OCEANEERING® DOUBLE-SHELL TANK ANNULUS WALL CLEANING SYSTEM

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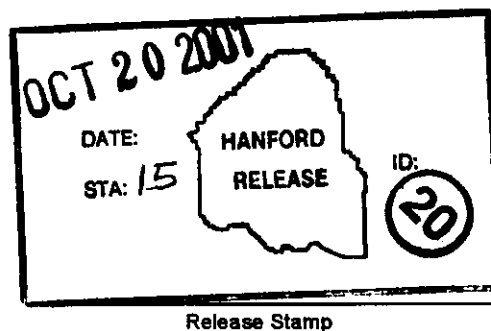
Abstract: This document presents the results of the hazard identification, evaluation, and control allocation for the use of the Oceaneering® tank wall cleaning system to remove scale from the outside of the primary tank wall of 241-AY-101.

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Safety Evaluation for the Oceaneering® Double-Shell Tank Annulus Wall Cleaning System

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

CH2MHILL
Hanford Group, Inc.

Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

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Date Published
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EXECUTIVE SUMMARY

The purpose of this report is to document the hazardous conditions that were identified for the Oceaneering® Double-Shell Tank (DST) wall cleaning system, evaluate the relationship of these hazardous conditions to the hazardous conditions currently included in the Safety Basis (SB) as documented in the hazard analysis database (HNF-SD-WM-TI-764), compare the hazardous conditions to the HNF-SD-WM-SAR-067, *Tank Farms Final Safety Analysis Report* (FSAR) analyzed accidents and controls, and identify situations where new controls may be required.

Seven hazardous conditions were identified with the potential for S3 (offsite individual) consequences having characteristics similar to analyzed accident 04, Flammable Gas Deflagration – Double-Shell Tank. All hazardous conditions with S3 (offsite individual) consequences were determined to be an F0 (beyond extremely unlikely) frequency. No controls are required for hazardous conditions with this frequency category in accordance with the control allocation guidelines contained in the FSAR.

Two hazardous conditions were identified with potential for S2 (onsite worker) consequences related to compressed gas and frequencies of F3 (anticipated). Since there is currently no approved FSAR representative accident analysis for releases of airborne radioactive material caused by compressed air disturbance (Boston, 2001), approval from the U.S. Department of Energy, Office of River Protection will need to be obtained prior to operation of the Oceaneering® DST wall cleaning system.

Hazardous conditions with S1 (facility worker impact) consequence and F3 (anticipated) frequency were found to be similar to current SB hazardous conditions that are addressed by existing Safety Management Programs such as Radiation Protection and Industrial Health and Safety.

Operation of the Oceaneering® DST wall cleaning system does not pose hazards that have the potential for high environmental (E2 or E3) but low safety consequences. All hazardous conditions identified were determined to be covered by existing FSAR hazardous conditions except for compressed air.

The potential for releases of contaminated soil due to a compressed air line rupture is mitigated by installing rubber matting between the air lines and the soil.

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TERMS

AC	Administrative Control
AIChE	American Institute of Chemical Engineers
AWF	Aging Waste Facility
Cat	category
CHG	CH2M HILL Hanford Group, Inc.
Cons	consequence
DST	double-shell tank
Env	environmental
Freq	frequency
FSAR	Final Safety Analysis Report
Grp	group
HEPA	high efficiency particulate air [filter]
ID	identification
LCO	Limiting Condition for Operation
MAR	material at risk
Mit	mitigative
NC	no controls
NDE	non-destructive examination
NFPA	National Fire Protection Association
ORP	U.S. Department of Energy, Office of River Protection
Prev	preventive
Rep Acc	representative accident
SB	Safety Basis
SC	Safety Class
SS	Safety Significant
SSC	Structure, system, and component
SST	single-shell tank
TSR	Technical Safety Requirement

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1.0 INTRODUCTION

1.1 PURPOSE

The tank farms safety basis (SB) provides a hazard and accident analysis in HNF-SD-WM-SAR-067, *Tank Farms Final Safety Analysis Report* (FSAR). Chapter 3 of the FSAR presents the results of the hazard and accident analyses performed for the facilities and operations described in Chapter 2.0, "Facility Description." Based on the results of the hazard and accident analyses, Safety-Class and Safety-Significant structures, systems, and components (SSCs); HNF-SD-WM-TSR-006, *Technical Safety Requirements* (TSRs); and Defense-in-Depth controls, are identified for protection of the public, onsite workers, and facility workers. In order to provide assurance that the SB adequately covers new or significantly revised activities in the tank farms, the activities are evaluated to identify unique hazardous conditions and then allocate controls necessary to prevent or mitigate them.

The purpose of this report is to document the hazardous conditions that were identified for corrosion removal from primary tank walls using the Oceaneering® Double-Shell Tank (DST) annulus wall crawler system, evaluate the relationship of these hazardous conditions to the hazardous conditions currently included in the SB as documented in the hazard analysis database (HNF-SD-WM-TI-764), compare the hazardous conditions to the FSAR analyzed accidents, identify situations where new accident analysis or controls may be required, and document the control decision process that established the allocated controls.

This document is not intended to authorize the activity. It documents the results of the safety evaluation process. The safety evaluation process is used to determine the adequacy of existing controls and whether the proposed activity is within the accident analysis envelope.

1.2 BACKGROUND

Tank 241-AY-101 is a DST Aging Waste Facility (AWF) tank located in the 200 East Area tank farm. During a recent visual inspection of the exterior of the 241-AY-101 primary tank, discolorations were observed on the wall surface. The discolorations could indicate significant primary tank wall thinning caused by corrosion. Visual inspections of the interior of the primary tank found discolorations in approximately the same location as those observed on the exterior of the primary tank that may indicate a potential leak location. It is believed that primary tank wall corrosion may have occurred as a result of condensation collecting on the exterior surface of the primary tank when the annulus ventilation system was not operating for long periods of time. As a result of this finding, ultrasonic inspection of the primary tank was initiated to determine if the corrosion has caused significant wall thinning.

An attempt was made to perform primary tank wall thickness measurements using a remotely controlled crawler device that moves an ultrasonic measuring probe across the tank wall. The crawler uses a magnetic wheel system to hold itself against the tank wall. The measurements could not be completed due to the crawler losing its grip on the wall as a result of corrosion collecting on the magnetic wheels.

Removal of corrosion products, as well as debris, left on the tank walls from construction, is necessary for visual evaluation of the wall and performance of non-destructive examination (NDE) to resolve tank wall thinning issues. To determine the thickness of the tank primary wall, Oceaneering® has been contracted to clean the exterior surface of the 241-AY-101 primary tank wall using a specially designed pneumatically driven crawler equipped with a high pressure water spray cleaning system. The cleaned wall will allow the ultrasonic measuring crawler to function properly.

Although this representative hazard evaluation was performed for use of the Oceaneering® DST annulus wall cleaning system on the primary wall of tank 241-AY-101, the results of this safety evaluation are applicable to use the Oceaneering® DST annulus wall cleaning system on other DST and AWF primary tank walls.

2.0 SYSTEM DESCRIPTION

The crawler system baseline design and operation is described in RPP-8474, Rev 0a, *241-AY-101 and 241-AY-102 Annulus Primary Tank Cleaning Plan*. The system information contained in this report defines the configuration and operating details that were used during the hazards analysis process.

2.1 The Oceaneering® Crawler

The Oceaneering® DST annulus wall cleaning system is designed to clean metal surfaces using high pressure water jets. The crawler can be used on vertical or horizontal surfaces and maintains contact with the surface it is cleaning using a vacuum system. An operator controls the movement of the crawler through a remote portable control box. Visual monitoring of crawler movement is achieved by use of cameras located in the tank annulus and on the crawler. The crawler is moved across the surface by four drive wheels. Each wheel is driven by its own air motor, which allows the crawler to be turned within its own radius. The crawler drive systems are engineered and tested to provide enough power to move the crawler at maximum vacuum.

Corrosion and scale removal is accomplished by a rotating multiple nozzle assembly (spray head) operating at a maximum pressure of 40,000-lb/in² gauge. An air motor powers the spray head rotation. As the crawler moves across the tank wall, the high pressure water spray strips away corrosion and other material leaving clean base metal. The spray system operating pressure is set to achieve a clean surface without significant removal of the base material.

Water and debris generated by the cleaning process is picked up by a high capacity vacuum system and collected in an external tank. The system leaves a clean, nearly dry, surface. High pressure water, compressed air, and vacuum are combined in an umbilical arrangement attached to the crawler. The various hoses are maintained in a bundled configuration by the use of plastic spiral wrap. Rubber matting is arranged under the umbilical and tracer gas lines to minimize the release of contamination in the case of an air line rupture. The umbilical is reeled out and recovered using a powered handling system. The United States Navy uses a similar system to remove paint and corrosion product from the hulls of ships and submarines prior to painting.

Multiple deployments of the remote crawler into the 241-AY-101 annulus for cleaning the 241-AY-101 tank wall will be required. Access to the 241-AY-101 annulus will be through the two 24-inch diameter access risers 88 and 89, located in the northeast and southwest quadrant of the tank. A approximately 2,000 square feet of tank surface area is planned to be cleaned.

2.2 Hydraulic Arm System

Two hydraulically actuated arms are mounted on the crawler to provide a second way of maintaining crawler contact with the primary tank wall. Each arm is hinged at the crawler and attached to a hydraulic cylinder. In the extended position the arms contact the annulus secondary containment wall, pressing the crawler against the primary tank wall. Two ball rollers are

attached to the outboard end of each arm. These rollers allow crawler movement when the hydraulic arms are in contact with the secondary containment wall. Hydraulic pressure is supplied by a power pack through small diameter flexible lines. The power pack reservoir is sized to minimize the amount of oil that could be released due to leaks or component failures. Pressure control devices are mounted on the crawler that limit the maximum pressure the arms can exert. The arms can be retracted to allow the crawler to maneuver around obstructions in the annulus.

2.3 High Pressure Water Supply

A skid mounted water pumping system located outside of the AY tank farm fence provides the Oceaneering® DST annulus wall cleaning system with 160-degree Fahrenheit, high pressure water at approximately 5-gallons per minute. Raw water will be supplied for the system from the fire hydrant directly north of the MO-439 change trailer and passes through a bag filter and two stainless steel filters, one 10-micron and one 6-micron, before entering a 40-gallon supply tank. The high pressure pump has very small internal clearances and must be protected from abrasive contaminants in the water supply. The pumping system uses a positive displacement pump, which ensures that water line breaks do not result in large quantities of high pressure water being released. Dual rupture disks, designed to rupture if the rated operating pressure is exceeded, protect the pump from overloading. A pulsation dampener is installed in the pump discharge line to eliminate high-pressure peaks and reduce pulsation in the high-pressure system. The engine control panel features automatic shutdown on low oil pressure and high engine cooling water temperature.

System pressure is adjustable to provide sufficient force to remove the corrosion and scale. Maximum operating pressure is set no higher than 40,000 lb/in² gauge. It has been calculated by Oceaneering® that a 40,000 lb/in² gauge spray flow could cut through one-half inch steel in approximately 20-minutes if the Oceaneering® crawler and spray nozzle rotation stop but the spray flow continues or in 4-hours if the crawler stops and the spray flow and spray nozzle rotation continue. The time required to penetrate the tank wall is proportional to the wall thickness.

2.4 Compressed Air System

The Oceaneering® DST annulus wall cleaning system relies on a 150 lb/in² gauge diesel powered portable air compressor located outside the tank farm fence area. The air compressor operates at flow rates up to 100 ft³/min. at a pressure of 100 lb/in² gauge. There are a total of six compressed air lines for two drive units, eight control solenoids, and a rotating spray head. The drive units are supplied from one 3/4-inch line, the solenoids from four 3/16-inch lines, and the spray head from a 1/2-inch line.

2.5 Crawler Vacuum System

A skid mounted diesel powered vacuum pump is used to remove water and debris generated by the cleaning process. The vacuum is sufficient to remove almost all cleaning water, leaving the cleaned surface slightly damp. No water is released into the tank annulus. The vacuum

produced by this unit also holds the Oceaneering® DST crawler to the tank wall. The vacuum system can create approximately 27-inches of mercury vacuum at the pump which translates to roughly 24-inches of mercury vacuum at the crawler. The air flow rate into the vacuum system at the crawler is approximately 275 ft³/min. A 10- to 12-inch hose from the annulus to the vacuum pump will be used to supply approximately 1,200 ft³/min of cooling air to the vacuum pump. Water and debris will be separated from the vacuum air and the process air and vacuum pump cooling air is returned to the tank annulus via a temporary duct (10-inch hose). All air used by the vacuum system is filtered by the annulus ventilation system thereby eliminating the need for separate exhaust air filtration. The estimated total flow rate through the return duct is approximately 1,500 ft³/min. The annulus ventilation system maintains the annulus space at a slightly negative pressure during operation of the system.

2.6 Waste Water Handling and Storage Tank

Water and debris generated by the cleaning process is separated from the vacuum system air stream at the vacuum system skid in a 500-gallon separator tank mounted on the skid. The tank contains baffles that separate the water and debris from the vacuum air stream. The waste-solids will collect in the bottom of the separation tank for disposal. The waste-water will be separated and pumped directly back into DST 241-AY-101. The waste solids will be packaged into 55-gallon drums for disposal.

2.7 Electrical Generator

A diesel powered 7.5 kilowatt 110/240 generator will be used to power all systems in the control trailer (cameras, monitors, etc.). The electrical generator will be staged outside the AY tank farm to reduce noise in the control trailer.

2.8 Remote Operator Station

The operator station is located in a convenient area near the riser that is being used to allow crawler access to the annulus. The Oceaneering® crawler movement is controlled with a spring-loaded joystick button to ensure that any operator departure shall immediately deactivate the Oceaneering® crawler high pressure spray. Constant surveillance of the crawler ensures that the operator is immediately aware if the spray nozzle rotation stops. Control signals are routed through a multiconductor cable from the control station to the crawler. The control cable is part of the crawler umbilical and is reeled out and recovered as necessary to prevent tangling.

2.9 Video System

A video system permits the Oceaneering® crawler operator to monitor the position and performance of the crawler. Two cameras will be mounted on the crawler and one or more cameras, with zoom lenses mounted on pan and tilt units, will be positioned in tank 241-AY-101 annulus through the 3-inch annulus risers. Signal cables for the crawler mounted cameras are part of the crawler umbilical. Each camera is linked to a display positioned for optimum viewing by the remote operator. Camera zoom, tilt, and pan controls can be accessed either by the operator or a nearby assistant.

2.10 Gantry/Winch System

A beam-style steel gantry/winch system will be used to lower/retrieve the crawler in the riser and to hold the crawler in place in the riser when not in use. The gantry/winch will be lifted into the AY tank farm with a crane. The gantry/winch will be located above the riser where the crawler is deployed.

2.11 Crawler Recovery System

Should the crawler become detached from the tank wall there are a variety of ways to recover the crawler. The umbilical can be used to pull the crawler back to the entry riser if the crawler is not tangled in tank annulus equipment. If this option is not available, then a long reach cable attachment tool can be inserted into an advantageously located riser and a retrieval cable attached that can lift the crawler to a position where other retrieval cables can be attached. The retraction cable(s) and umbilical can be coordinated to allow vertical height control of the crawler to clear annulus interference and allow return of the crawler to the entry riser.

2.12 Diesel Fuel Storage Tank

The high-pressure water pump, vacuum pump, air compressor, and electrical generator are diesel and/or gas fuel operated. A fuel truck with a mounted 50- to 100-gallon capacity fuel tank and pump to fuel the equipment will be staged outside the AY tank farm.

2.13 Tracer Gas

Very small leaks are difficult to identify in a DST primary tank wall. A non-toxic inert tracer gas will be released into the tank headspace and the air passing through the crawler vacuum system sampled and analyzed to determine if a leak is present. Tracer Research has been subcontracted by Oceaneering® to perform tracer gas leak testing at tank 241-AY-101. Tracer Research will provide the fittings and equipment necessary to introduce the tracer gas into tank 241-AY-101 headspace. The tracer gas supply system consists of a 300 lb/in² gauge bottle, located outside the tank farm area, connected to the tank headspace injection point with flexible tubing. The tracer gas supply line will be connected to the tank using a flange connection on a primary tank riser. The gas supply has an initial regulated charge of approximately 150 lb/in² gauge that is reduced to approximately 15 lb/in² gauge. The vacuum system air flow will be sampled using a small pump connected to the suction side of the Oceaneering® DST annulus wall cleaning vacuum system. This arrangement will prevent potential unfiltered annulus atmosphere releases by ensuring that the sampling system is under negative pressure.

Tracer gas will be added to the primary tank headspace at a rate of 22-pounds per day. Tracer Research will establish a baseline for the tracer gas test by sampling the primary tank air space before the tracer gas is injected. Tracer gas will be injected into the primary tank air space in an amount sufficient to provide an acceptable concentration for testing purposes. A Tracer Research trained technician will operate the injection system and maintain the concentration level of the tracer gas throughout each testing day. After the crawler head is positioned over the suspect area, an Oceaneering® technician will collect two 120-cubic centimeter samples from

the crawler vacuum line. Tank farm personnel will monitor the samples for radioactive contamination prior to transport to the mobile laboratory. One of the two samples will be analyzed for the presence of the tracer gas. The second sample will only be analyzed should the tracer gas be detected in the first analysis. Preliminary analysis will be performed utilizing a standard gas chromatograph located in the Tracer Research mobile laboratory, prior to moving the crawler to the next test location.

During the tracer gas test the primary ventilation system exhaust flow rate will be maintained at approximately 300 ft³/min. Negative pressure in the waste storage tank will be maintained at approximately 1- to 3-inches H₂O.

2.14 General Equipment Location

The control trailer, high pressure pump skid, vacuum pump unit and liquid separator, air compressor, hydraulic power pack, electric generator, tracer gas bottle, and fuel supply truck will be located outside the AY tank farm fence. Process fluids, compressed air, and control signals will be routed to the crawler via an integrated umbilical line which will consolidate all of the lines into a single bundle before the umbilical passes through the tank farm fence. Separate cables for the annulus cameras and lighting will be routed from the control trailer to the tank annulus. The vacuum pump cooling air supply duct will be routed from a tank annulus riser directly to the vacuum pump. The return air ducting from the vacuum pump will be routed directly to a tank annulus riser. The portion of the crawler umbilical that will be in the tank annulus will be staged near the riser being used for crawler access. The umbilical hoist frame will be set up over the riser being used for annulus access. Tracer gas will be routed to a 3-inch tank riser via a small diameter flexible hose.

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3.0 HAZARD IDENTIFICATION AND EVALUATION

3.1 METHODOLOGY

The “What-If” Checklist technique was used to perform the hazard evaluation of the Oceaneering® DST annulus wall cleaning system. In this technique, a team leader systematically guides the hazard analysis team through the system/process being evaluated using a brainstorming technique incorporating relevant hazard checklists and team members experience. A Hazardous Material/Energy Source Checklist (Table 3-1) was used as the basis for identifying potential hazards.

The hazard evaluation was performed by an interdisciplinary team to identify potential hazardous conditions within the agreed upon scope of corrosion removal from primary tank walls using the Oceaneering® DST annulus wall cleaning system. During the hazard evaluation process, hazardous conditions were formulated, safety consequence and event frequency estimated, and possible mitigative and/or preventive measures identified and discussed. This process is recognized by the American Institute of Chemical Engineers (AIChE) and is described in AIChE (1992), *Guidelines for Hazard Evaluation Procedures*. The results of the process were recorded using a tabular format. The definitions of the information developed during the hazards identification/evaluation are found in Section 3.3.

Mission Impact information was also captured during the hazard evaluation. Safety consequence and environmental impact information are important risk indicators but do not fully communicate all of the significant project risk concerns in this case. Mission Impact is intended to provide a measure of the potential for a hazardous condition to result in loss of use of a DST to support future tank farm missions.

Because the “What-If” Checklist technique tends to be qualitative in nature, the expertise and experience of the team is of primary importance in establishing the credibility of the analysis. A short resume of each team member is included in Appendix A to document the expertise and experience level of each team member.

One of the parts of the hazard evaluation technique is the division of the process or activity into discrete segments. Each segment is designed to focus the efforts of the team for the efficient identification of hazardous conditions. The “What-If” Checklist hazard evaluation for the corrosion removal from primary tank walls using the Oceaneering® DST annulus wall cleaning system was based on the following segments chosen to capture points in the process where hazardous conditions could result in significant consequences.

- Node 1: Operation of the Oceaneering® Crawler in Annulus to Remove Corrosion Scale
- Node 2: General Activity: Installation and Removal of Oceaneering® Crawler and Support Systems
- Node 3: General Activity: Oceaneering® Crawler and Support Systems
- Node 4: Other - Natural Phenomena

Table 3-1. Hazardous Material/Energy Source Checklist

A. Electrical	E. Kinetic - Rotational	J. Explosives/Pyrophorics	M. Hazardous Materials
Y <input type="checkbox"/> N <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>
1. Battery banks <input type="checkbox"/>	1. Centrifuges <input type="checkbox"/>	1. Caps <input type="checkbox"/>	1. Alkali metals <input type="checkbox"/>
2. Cable runs <input type="checkbox"/>	2. Motors <input type="checkbox"/>	2. Dynamite/high explosives <input type="checkbox"/>	2. Asphyxiants <input type="checkbox"/>
3. Diesel generators <input type="checkbox"/>	3. Turbines <input type="checkbox"/>	3. Scrub chemicals <input type="checkbox"/>	3. Biologicals <input type="checkbox"/>
4. Transformers <input type="checkbox"/>	4. Pumps <input type="checkbox"/>	4. Dusts <input type="checkbox"/>	4. Carcinogens <input type="checkbox"/>
5. High voltage <input type="checkbox"/>	5. Cooling tower fans <input type="checkbox"/>	5. Hydrogen <input type="checkbox"/>	5. Corrosives <input type="checkbox"/>
6. HVAC heaters <input type="checkbox"/>	6. Laundry equipment <input type="checkbox"/>	6. Gases, other flammable <input type="checkbox"/>	6. Oxidizers <input type="checkbox"/>
7. Motors <input type="checkbox"/>	7. Shop equipment <input type="checkbox"/>	7. Nitrites/nitrites <input type="checkbox"/>	7. Toxics <input type="checkbox"/>
8. Pumps <input type="checkbox"/>	8. Power tools <input type="checkbox"/>	8. Peroxides/hydrates <input type="checkbox"/>	8. Heavy metals <input type="checkbox"/>
9. Power tools <input type="checkbox"/>	9. Other <input type="checkbox"/>	9. Pu and U metal <input type="checkbox"/>	9. Other <input type="checkbox"/>
10. Switch gear <input type="checkbox"/>		10. Sodium/phosphorus <input type="checkbox"/>	
11. Service outlets, fittings <input type="checkbox"/>	F. Kinetic - Linear	11. Combustible vapors <input type="checkbox"/>	N. Ionizing Radiation Sources
12. Electrical equipment <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>	12. Other <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>
13. Transmission lines <input type="checkbox"/>	1. Cars, trucks, buses <input type="checkbox"/>		1. Fissile material <input type="checkbox"/>
14. Underground wires <input type="checkbox"/>	2. Forklifts, dollies, carts <input type="checkbox"/>	K. Nuclear Criticality	2. Radiography equipment <input type="checkbox"/>
15. Facility wiring <input type="checkbox"/>	3. Railroad <input type="checkbox"/>	(fissile material present)	3. Radioactive material <input type="checkbox"/>
16. Other <input type="checkbox"/>	4. Obstructions <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>	4. Radioactive sources <input type="checkbox"/>
B. Thermal	5. Crane loads <input type="checkbox"/>	1. Vaults <input type="checkbox"/>	5. Other <input type="checkbox"/>
Y <input type="checkbox"/> N <input type="checkbox"/>	6. Pressure vessel blowdown <input type="checkbox"/>	2. Temporary storage areas <input type="checkbox"/>	P. External events
1. Bunsen burner/hot plates <input type="checkbox"/>	7. Other <input type="checkbox"/>	3. Shipping and receiving area <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>
2. Electrical equipment <input type="checkbox"/>	G. Mass, Gravity, Height	4. Filters <input type="checkbox"/>	1. Explosion <input type="checkbox"/>
3. Furnaces/boilers/heater <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>	5. Vessels/tanks <input type="checkbox"/>	2. Fire <input type="checkbox"/>
4. Steam lines <input type="checkbox"/>	1. Human effort <input type="checkbox"/>	6. Casks <input type="checkbox"/>	3. Other sites (interactions):
5. Welding torch/arc <input type="checkbox"/>	2. Stairs <input type="checkbox"/>	7. Burial ground <input type="checkbox"/>	3.a Toxic materials <input type="checkbox"/>
6. Diesel units/fire box/exhaust line <input type="checkbox"/>	3. Lifts and cranes <input type="checkbox"/>	8. Storage racks <input type="checkbox"/>	3.b Flammable liquids/gases <input type="checkbox"/>
7. Radioactive decay heat <input type="checkbox"/>	4. Bucket and ladder <input type="checkbox"/>	9. Canals and basins <input type="checkbox"/>	3.c Explosive materials <input type="checkbox"/>
8. Exposed hot components <input type="checkbox"/>	5. Trucks <input type="checkbox"/>	10. Decontamination solution <input type="checkbox"/>	3.d Large water sources <input type="checkbox"/>
9. Power tools <input type="checkbox"/>	6. Slings <input type="checkbox"/>	11. Trucks, forklifts, dollies <input type="checkbox"/>	3.e Large quantities of asphyxiants <input type="checkbox"/>
10. Convective <input type="checkbox"/>	7. Hoists <input type="checkbox"/>	12. Hand carry <input type="checkbox"/>	3.f Other <input type="checkbox"/>
11. Solar <input type="checkbox"/>	8. Elevators <input type="checkbox"/>	13. Cranes/lifts <input type="checkbox"/>	Q. Vehicles In Motion
12. Cryogenic <input type="checkbox"/>	9. Jacks <input type="checkbox"/>	14. Hot cells, assembly, inspection <input type="checkbox"/>	(external to facility)
13. Lighting <input type="checkbox"/>	10. Scaffold and ladders <input type="checkbox"/>	15. Laboratories <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>
14. LASER Equipment <input type="checkbox"/>	11. Pits and excavations <input type="checkbox"/>	16. Other <input type="checkbox"/>	1. Airplane <input type="checkbox"/>
15. Other <input type="checkbox"/>	12. Elevated doors <input type="checkbox"/>	L. Flammable Materials	2. Helicopter <input type="checkbox"/>
C. Friction	13. Vessels/tanks <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>	3. Train <input type="checkbox"/>
Y <input type="checkbox"/> N <input type="checkbox"/>	14. Other <input type="checkbox"/>	1. Packing materials <input type="checkbox"/>	4. Truck/bus/car <input type="checkbox"/>
1. Belts <input type="checkbox"/>	H. Pressure - Volume	2. Rags <input type="checkbox"/>	5. Cranes <input type="checkbox"/>
2. Bearings <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>	3. Gasoline <input type="checkbox"/>	5. Other <input type="checkbox"/>
3. Fans <input type="checkbox"/>	1. Boilers <input type="checkbox"/>	4. Lubricant oil <input type="checkbox"/>	R. Natural Phenomena
4. Gears <input type="checkbox"/>	2. Surge tanks <input type="checkbox"/>	5. Coolant oil <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>
5. Motors <input type="checkbox"/>	3. Autoclaves <input type="checkbox"/>	6. Paint solvent <input type="checkbox"/>	1. Earthquake <input type="checkbox"/>
6. Power tools <input type="checkbox"/>	4. Test loops <input type="checkbox"/>	7. Diesel fuel <input type="checkbox"/>	2. Flood <input type="checkbox"/>
7. Other <input type="checkbox"/>	5. Compressed gas bottles <input type="checkbox"/>	8. Hydraulic fluids <input type="checkbox"/>	3. Lightning <input type="checkbox"/>
D. Corrosives	6. Pressure vessels <input type="checkbox"/>	9. Buildings and contents <input type="checkbox"/>	4. Rain <input type="checkbox"/>
Y <input type="checkbox"/> N <input type="checkbox"/>	7. Stressed members <input type="checkbox"/>	10. Trailers and contents <input type="checkbox"/>	5. Snow, freezing weather <input type="checkbox"/>
1. Acids <input type="checkbox"/>	8. Compressors <input type="checkbox"/>	11. Grease <input type="checkbox"/>	6. Straight wind <input type="checkbox"/>
2. Caustics <input type="checkbox"/>	9. Compressed gas receivers <input type="checkbox"/>	12. Hydrogen <input type="checkbox"/>	7. Dust devil <input type="checkbox"/>
3. Natural chemicals <input type="checkbox"/>	10. Negative pressure collapse <input type="checkbox"/>	13. Nitric acid <input type="checkbox"/>	8. Tornado <input type="checkbox"/>
4. Decontamination solution <input type="checkbox"/>	11. Steam headers and lines <input type="checkbox"/>	14. Organics <input type="checkbox"/>	9. Ashfall <input type="checkbox"/>
5. High temperature waste <input type="checkbox"/>	12. Positive displacement pumps <input type="checkbox"/>	15. Gases - others <input type="checkbox"/>	10. Range fire <input type="checkbox"/>
6. Other <input type="checkbox"/>	13. Hydraulic Systems <input type="checkbox"/>	16. Liquids - others <input type="checkbox"/>	11. Other <input type="checkbox"/>
	14. Other <input type="checkbox"/>	17. Other <input type="checkbox"/>	

3.2 ASSUMPTIONS

The following assumptions were made during the hazards identification/evaluation.

3.2.1 Assumptions Related To Safety Basis Concerns

- The Frequency Category no controls (NC) and the Safety Consequence Category no controls (NC) for each hazardous condition were estimated based on the crawler design as documented in RPP-8474, Rev 0a.
- The crawler above ground support systems are designed to confine any radioactive and hazardous material.
- Compressed air used to power the Oceaneering® crawler and rotating spray assembly is exhausted into the annulus (potential for slight pressurization of annulus if the 241-AY-101 annulus ventilation system fails).
- The high pressure hose and connection design limits energy release as a result of failures. The connections have a cable attached, which keeps the connection ends tied together and prevents whipping should they become detached.
- The frequency of flammable gas deflagrations in the annulus caused by crawler insertions is beyond extremely unlikely (F0) based on the amount of waste required to be present in the tank annulus to achieve a flammable gas concentration above the Lower Flammability Limit (LFL) in the annulus (i.e., mistransfer or primary tank leak of > 12,000-gallons into the annulus prior to crawler insertion).
- Reaction rate of waste with exposed aluminum surface of the crawler is not sufficient to produce hydrogen in quantities that would result in the annulus atmosphere exceeding LFL.
- To the extent possible the Oceaneering® DST annulus wall cleaning support systems will be located outside the tank farm fence. This includes the diesel powered vacuum pump, the compressed air supply, the diesel fuel supply, the diesel generator, and the tracer gas bottle.
- Only standard industrial hazards exist for the Oceaneering® DST annulus wall cleaning support systems (high temperature diesel exhaust, rotating equipment, electrical equipment, diesel fuel, gasoline, etc.) and are addressed via the tank farm Safety Management Programs. These hazards are located outside the AY tank farm fence.
- Fuel spills, from a truck mounted 50- to 100-gallon capacity fuel tank placed outside the tank farm fence, into tank 241-AY-101 and creating an In-Tank Fuel Fire are not considered a credible threat.

- The hydraulic power pack for the crawler hydraulic arms will have a small capacity reservoir, which will limit the potential quantity of an oil spill. The hydraulic cylinders for the arms hold a maximum of 8.7-ounces of hydraulic oil each.
- The hydraulic cylinders for the arms will be supplied with Chevron Hydraulic Oil AW ISO46, Hanford MSDS #026852. This oil is considered non-hazardous and has been approved for use on the Hanford Site.
- A proprietary tracer gas chosen for the leak test will include a Material Safety Data Sheet to ensure non-toxicity to tank farm workers.

3.2.2 Assumptions Related to Mission Impact

- No radioactive material has been found in the annulus.
- The crawler drive systems are engineered and tested to provide enough power to overcome the vacuum and move the crawler on vertical surfaces. There is no concern with the possibility of not being able to move the crawler due to excess vacuum.
- The umbilical is made up of the vacuum line, flexible compressed air lines, flexible small diameter hydraulic and water lines, and one or more control/signal cables. The design of the umbilical maintains a bundled configuration that prevents abrasion degradation and limits snagging and tangling potential.
- The primary tank wall thickness for tank 241-AY-101 is shown on drawing H-2-64449. The bottom knuckle and first 3-feet of the tank is 7/8-inch thick, it is 3/4-inch thick for the next 9-feet, 1/2-inch thick for the next ~20-feet and 3/8-inch thick (1 1/2-feet above the maximum liquid level) to the top.
- The cleaning water operating pressure will be set to achieve a clean surface without significant base material removal during normal operation of the system. It has been calculated by Oceaneering® that a 40,000 lb/in² gauge spray flow could cut through one-half inch steel in approximately 20 minutes if the Oceaneering® crawler and spray nozzle rotation stop but the spray flow continues or in 4 hours if the crawler stops and the spray flow and spray nozzle rotation continue. The time required to penetrate the tank wall is proportional to the wall thickness.
- Damage to the carbon steel surface of the tank by mechanical contact with the high pressure spray nozzles is not considered credible. The nozzles are brittle when side loaded and would break off causing the Oceaneering® crawler to no longer be operable.
- Any significant failure of a spray nozzle will result in a loss of pressure for all cleaning nozzles in the nozzle rotating assembly (a result of the flow limitation of the positive displacement pump).

- The Oceaneering® DST annulus wall cleaning system control design includes a “dead man” control that requires continuous operator action to maintain high pressure cleaning water flow to the crawler. This reduces the likelihood of crawler stoppage resulting in tank wall damage.
- Failures of the “dead man” control were not postulated. It is assumed that the design of the switch will provide for reliability and ease of use. Deliberate operator actions to disable the switch are also not postulated.
- The potential for tank wall damage is limited to minor wall scoring if the spray nozzle assembly ceases to rotate while the Oceaneering® crawler is moving.
- There are no spray head failures that will cause penetration of the tank wall as long as the Oceaneering® crawler continues to travel at its normal rate.
- The flow rate of the high pressure water supply is limited to about 5-gallons per minute by design and operating constraints of the positive displacement pump.
- Visual observation of the Oceaneering® crawler movement is necessary. At least one stationary camera in the tank annulus is required.
- The waste water from the wall cleaning process will be separated and pumped directly back into tank 241-AY-101. The waste solids will be sampled and packaged into 55-gallon drums for disposal.
- Normal tank farm radiation monitoring and control requirements will be in force during the operation of the Oceaneering® DST annulus wall cleaning system.

3.3 DEFINITIONS OF TABLE COLUMN HEADINGS

The raw data table (Table B1 of Appendix B) uses the following column headings:

ID: The item identification (ID); used to record a unique identifier for the hazardous condition.

Location/Activity: Points in a system or process where the What-If/Checklist questions are applied.

Hazardous Condition: The hardware failures, operational faults, and conditions that could result in undesired consequences combined with a description of the consequences.

Cause: The cause leading to the departure from the normal conditions expected during system operation. Identifying causes is important to identifying potential preventive or mitigative controls or features for significant hazardous conditions. This column identifies the sequence of hardware or operational faults required to produce the postulated hazardous condition.

MAR: Material at risk – A description of the type, form, and quantity (when applicable) of material that may be affected by the occurrence of the Hazardous Condition.

Consequence(s): The potential consequences that could result from the postulated deviation. The information in this column is used in the formulation of the Hazardous Condition statement.

Engineered Safety Features: Structures, Systems, or Components that may reduce the consequence or frequency of a Hazardous Condition.

Administrative Safety Features: Administrative controls that may reduce the consequence or frequency of a Hazardous Condition.

Safety Cat NC: Consequence Category, No Controls – The consequence category is a code designator for the level of consequence associated with a hazard condition, assuming no controls exist, to either prevent or mitigate the consequences. The consequence ranking is a “first cut”, qualitative estimate of the safety severity of the consequences assuming no controls are present. The following system is used:

- S3 Potential significant radiological dose consequences or chemical exposure to the offsite population.
- S2 Potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility.
- S1 Potential industrial injury, low radiological dose consequences or chemical exposure to the facility worker.
- S0 Negligible safety concerns for the facility worker

Freq Cat NC: Frequency Category, No Controls – The frequency category is a “first cut”, qualitative estimate of the likelihood of the hazardous condition assuming no controls are present. The following system is used:

- F3 Events that are expected to occur one or more times during the lifetime of the facility, categorized as “anticipated” events. The frequency range associated with this category is $> 1\text{E-}02/\text{yr}$.
- F2 Events that could occur during the lifetime of the facility, but with low probability are categorized as “unlikely”. The frequency range associated with this category is $1\text{E-}04/\text{yr}$ to $1\text{E-}02/\text{yr}$.
- F1 Events not expected to occur during the lifetime of the facility are categorized as “extremely unlikely”. The frequency range associated with this category is $1\text{E-}06/\text{yr}$ to $1\text{E-}04/\text{yr}$.

- F0 Events categorized as “beyond extremely unlikely”, with a frequency less than 1E-06/yr. Events in this category (such as a meteor strike) are so unlikely that they generally do not require special controls.

Mission Impact: A code for specifying operational consequences. This estimate gives a qualitative measure of the operational consequences of hazardous conditions. The following system is used:

- M3 Types of events in this category include conditions that penetrate the tank wall below the waste level and require transfer of waste from the tank to stop waste leaking into the annulus. Tank repair and transfer/cleanup of waste leaked to annulus is required prior to returning the tank to service.
- M2 Types of events in this category include conditions that penetrate the tank wall above the waste level or that damage the tank wall. Tank repair is required prior to returning the tank to service.
- M1 Types of events in this category include damage to crawler or annulus SSCs. Events in this category have the potential for delay of wall cleaning activities while recovering from the condition.

Also included in this category is the condition involving a pre-existing leak. CH2M HILL Hanford Group, Inc. has declared the tank 241-AY-101 out of service for waste additions because of suspected leaks. The tank will remain in this status until primary tank wall integrity has been verified. Therefore, discovery of a pre-existing leak will not change the operational status of the tank. Tank repair is required prior to returning the tank to service.

- M0 Events in this category have negligible potential operational impact.

Remarks: Miscellaneous observations or clarifying comments for a given item.

Tables B2, B3, and B4 in Appendix B contain the Item ID, Hazardous Condition, Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Impact Category (Env Cat). Column identifiers (e.g., Hazardous Condition) used in Tables B2, B3, and B4 of Appendix B are consistent with the previously cited definitions other than Environmental Category that is described below.

Env Cat: Environmental Category, No Controls – The consequence category is a code designator for the level of environmental impact associated with a hazard condition, assuming no controls exist to either prevent or mitigate the consequences. The consequence ranking is a “first cut”, qualitative estimate of the environmental severity of the consequences assuming no controls are present. The following system is used:

- E0 No significant environmental effect outside the facility confinements systems.

- E1 Limited environmental discharge of hazardous material outside the facility.
- E2 Large environmental discharge of hazardous material within the plant site boundary.
- E3 Significant environmental discharges of hazardous material outside the plant site boundary.

Tables B5, B6, B7, and B8 in Appendix B contain the Item ID, Hazardous Condition, Cause, Frequency Category without Controls (Freq Cat NC), and the Mission Impact designator. Column identifiers (e.g., Hazardous Condition) used in these tables are also consistent with the previously cited definitions

Tables B9 and B10 also present information captured in Table B1 as well as additional information useful in demonstrating analyzed accident and potential control applicability. The following additional column identifiers, derived from HNF-SD-WM-TI-764, *Hazard Analysis Database Report*, have been used in Tables B9 and B10, Appendix B:

- **BIN:** A code that describes the release attributes for high Safety Consequence (S2 and S3) and Worker Hazard (S1) with anticipated frequency (F3) Hazardous Conditions.
- **Cause Grp:** An alpha/numeric code used to permit sorting of data by the cause of a Hazardous Condition.
- **Rep Acc:** Representative Accident – An alpha/numeric code used to specify the analyzed accident by which the specified Hazardous Condition is represented. Only hazardous conditions with high Safety Consequence (S2 or S3) are assigned representative accidents.
- **Potential Prev SSC:** SSCs from the analyzed accident in the SB, determined by this hazard evaluation to apply to the hazardous condition, that provide a preventive function.
- **Potential Prev TSR:** Technical Safety Requirements (TSRs) for the analyzed accident in the SB, determined by this hazard evaluation to apply to the hazardous condition, that provide a preventive function.
- **Potential Mit SSC:** SSCs from the analyzed accident in the SB, determined by this hazard evaluation to apply to the hazardous condition, that provide a mitigative function.
- **Potential Mit TSR:** TSRs for the analyzed accident in the SB, determined by this hazard evaluation to apply to the hazardous condition, that provide a mitigative function.
- **Control Memo:** A short description of the analyzed accident that is the source of the safety SSCs and TSRs.

3.4 HAZARDS IDENTIFICATION/EVALUATION RESULTS

The initial hazard evaluation team meeting was held on May 29, 2001. A second meeting was conducted on September 25, 2001, to evaluate changes in design that had occurred after the first meeting. Hazardous conditions identified during the second meeting are identified by the addition of “-NEW” and a number. Additional information was obtained on October 9, 2001, and October 10, 2001, so a third meeting was held (mini-“What If”) for concerns relating to aluminum components on the crawler. Hazardous conditions identified during this meeting are identified by the addition of “-XNEW” and a number.

During the control allocation process, changes were made to the hazardous condition information developed during the “What If” team meetings. These changes were based upon additional knowledge or resulted from consistency checks of similar hazardous conditions that are already part of the SB. Changes to the “What If” data due to the meetings subsequent to the May 29, 2001, meeting, as well as changes made as a result of the control allocation process, are summarized in Table D1, Appendix D.

The hazards identification/evaluation team identified hazardous conditions associated with the Oceaneering® DST annulus wall cleaning system tank wall corrosion removal activity. The information developed during team deliberations is presented in Table B1. 48 hazardous conditions were identified as a result of the “What-If” Checklist process on May 29, 2001. 14 additional hazardous conditions were identified during the September 25, 2001, meeting for a total of 62. Four more hazardous conditions were added on October 10, 2001, as a result of hazardous conditions being identified, related to the presence of aluminum components on the crawler, bringing the total to 66. Item IDs PTWSR-38, PTWSR-39, and PTWSR-41 through PTWSR-48 capture potential hazards that were not developed into hazardous conditions and are not included in the hazardous condition summaries, accident analyses, or control decision process.

The hazardous conditions are listed by Consequence Category in Tables B2, B3, B4, and B5. These tables contain the item ID, Hazardous Condition, Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Impact Category (Env Cat).

An additional column for capturing an estimate of Mission Impact was added to the table B1 to provide insight into the operational impacts of the corrosion removal process. Tables B6, B7, B8, and B9 list hazardous conditions grouped according to Mission Impact. These tables contain the Item ID, Hazardous Condition, Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Impact Category (Env Cat).

Table B10, Appendix B, presents a grouping, based on accident similarity, of the hazardous conditions with S2 and S3 safety consequence.

3.4.1 Safety Impact Summary

The Hazardous Condition totals according to Safety Consequence are:

- 29 S0, negligible safety concerns for the facility worker;
- 18 S1, potential industrial injury, low radiological dose consequences or chemical exposure to the facility worker;
- 2 S2, potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility; and
- 7 S3, potential significant radiological dose consequences or chemical exposure to the offsite population.

3.4.2 Environmental Impact Summary

The Environmental Category for the hazardous conditions was established by convention to mirror the Safety Consequence Category. For example, an S1 consequence would equate to an E1 Environmental Consequence. The exceptions to this convention were hazardous conditions related to Occupational Safety and Radiation Protection concerns where no release of radioactive or hazardous material occurred. There are two cases where this condition exists. In one case the Environmental Consequence category is E0, indicating that no release is expected to take place. Three hazardous conditions were identified with S1-E0 consequences. The other case occurs when the Environmental Consequence category is high (E2 or E3) but the safety consequence is very low (S0) indicating that a major tank leak to the soil subsurface has occurred. This type of release has no significant short-term exposure effects to people. No hazardous conditions with this characteristic were identified during the evaluation of the Oceaneering® DST annulus wall cleaning system.

3.4.3 Mission Impact Summary

Mission Impacts are difficult to assess and are not normally part of a tank farms hazard analysis. The primary intent of evaluating Mission Impact for this safety evaluation was to identify potential scenarios for breaching the tank wall and resulting impacts to the tank farm mission due to loss of a DST. The information provided in this section is intended to permit more informed management decision making.

The Hazardous Condition totals by Mission Impact are:

- 20 M0 events that have negligible potential operational impact.
- 14 M1 events that have the potential for delay of wall cleaning activities while recovering from the condition. Also included in this category are the conditions involving a pre-existing hole.
- 11 M2 events that include conditions caused by failures of the crawler cleaning system that result in penetration the tank wall above the waste level or that damage the tank wall. Tank repair is required prior to returning the tank to service.

- 11 M3 events that include conditions caused by failures of the crawler cleaning system that result in penetration the tank wall below the waste level and require transfer of waste from the tank to stop waste leaking into the annulus. Tank repair and transfer/cleanup of waste leaked to annulus is required prior to returning the tank to service.

The greatest Mission Impact results from Oceaneering® crawler failures that cause penetration of the tank wall below the waste level. Since the consequence of such a failure was evaluated as an uncontrolled event, the size of the penetration is not assumed to be limited. These hazardous conditions were assigned frequencies of F2 or F1 (Unlikely or Extremely Unlikely respectively). The result of a tank wall penetration below the waste surface would be movement of tank waste into the vacuum system and waste water storage tank with potentially high radiation fields in aboveground tank farm areas. Discovery of this condition is expected to occur quickly as normal radiation protection requirements would require monitoring of the lines where material is being transported from the tank annulus. There is the potential for significant quantities of waste to leak into the annulus. Recovery from this situation could involve emergency transfer of waste from the primary tank and annulus. There were three hazardous conditions identified for this concern.

Mission Impact would also be high if a flammable gas deflagration were to occur in the annulus. However, the frequency assigned to this type of event was F0 (beyond extremely unlikely).

Moderate Mission Impact was associated with Oceaneering® crawler failures that cause penetration of the tank wall above the tank waste or could cause significant thinning of the tank wall without penetration. Since the consequence of such a failure was evaluated as an uncontrolled event, the size of the penetration is not assumed to be limited. These types of hazardous conditions were assigned frequencies of F2 or F1 (Unlikely or Extremely Unlikely respectively). Discovery of this condition is expected to occur quickly as normal radiation protection requirements would require monitoring of the lines where material is being transported from the tank annulus. The difference between the above waste level and below waste level penetration is that the above waste level penetration would only draw limited quantities of radioactive contamination into the crawler vacuum system and waste water storage tank. Penetration of the tank wall above the waste would not result in waste leaking into the annulus.

Minor Mission Impact was assigned to hazardous conditions where a pre-existing tank wall failure was opened up by the cleaning action of the Oceaneering® crawler. Such pre-existing failures were postulated above and below the waste surface. A frequency of occurrence of such events was considered to be Anticipated (F3) by the team. Discovery of this condition is expected to occur quickly as normal radiation protection requirements would require monitoring of the lines where material is being transported from the tank annulus. These hazardous conditions were assigned a lower Mission Impact based on the assumption that anticipated pre-existing tank wall failure sizes would be very small.

The controls that minimize the risk of wall damage are:

- Requirement for camera to be operating to perform wall cleaning,
- “Dead man” control arrangement requiring continuous operator action to maintain high pressure water flow to crawler, and
- Trained and experienced operators provided by the Oceaneering® company for operating the crawler.

3.4.4 Hazardous Condition Evaluation

The FSAR hazard and accident analysis methodology requires that hazardous conditions with significant risk to the offsite public, onsite worker or facility worker be evaluated for application of controls to reduce the risk to acceptable levels. Risk is a function of consequence and frequency. Hazardous conditions with low safety risk and significant environmental risk are also identified to ensure that the environment is protected. The number of hazardous conditions in the general categories of S3 (offsite public), S2 (onsite worker), and S1-F3 (facility worker) are as follows. There were no hazardous conditions in the low safety impact – high environmental impact category.

- 7 Hazardous conditions with S3 consequence similar to an existing Representative Accident (Rep Acc 04),
- 2 Hazardous conditions with S2 consequence not similar to an existing Representative Accident, and
- 6 S1-F3 Hazardous conditions (not assigned to a representative accident per FSAR methodology),

Flammable Gas Related Conditions

All seven of the S3 safety category hazardous conditions have similar characteristics to Representative Accident 04, Flammable Gas Deflagration - DST. There are three hazardous conditions involving flammable gas presence caused by the action of radiation on water. A frequency of F0 was assigned based on the likelihood of the occurrence of an undetected waste mistransfer or primary tank leak of >12,000-gallons into the annulus during crawler operations. This is the minimum quantity of waste required to generate sufficient flammable gas to reach the lower flammability limit (HNF-SD-WM-TSR-006, Appendix A). Since these hazardous conditions were assigned a frequency category of F0 (beyond extremely unlikely) no controls are required. Four hazardous conditions were identified related to the production of hydrogen by chemical reaction of waste with aluminum components in the crawler. These hazardous conditions were assigned a frequency of occurrence of F0 based on the potential quantities of hydrogen produced from reactions of aluminum with high pH waste taking into consideration area and quantity of aluminum available for reaction; quantity and rate of waste available to participate in a reaction; capability to rapidly detect waste in the vacuum system due to the presence of ionizing radiation; and operator response to observed crawler failures. The FSAR

does not require consideration of controls for hazardous conditions assigned a frequency of occurrence of F0.

Compressed Gas Related Conditions

The two hazardous conditions assigned a safety consequence of S2 were related to dispersal of contaminated soil by compressed gases. These hazardous conditions were conservatively assigned an occurrence frequency of F3 (anticipated). The consequence and frequency were assigned based on uncertainties of levels of soil contamination and dispersability. The Oceaneering® DST annulus wall cleaning system has compressed air powered motors that provide crawler movement and spray nozzle assembly rotation. Item ID PTWSR-26 captures concerns regarding potential compressed air line failures that could result in disturbance of contaminated soil located in the tank farm due to the crawler operation. The Oceaneering® DST annulus wall cleaning system also uses bottled compressed tracer gas, which is located outside the tank farm fence, which is injected into the primary tank headspace. This allows detection of small primary tank penetrations above the waste surface. A small diameter flexible line is used to route the gas to a tank riser where it is injected into the tank headspace at a low flow rate. Item ID PTWSR-52-NEW1 captures concerns regarding potential line failures that could result in disturbance of contaminated soil located in the tank farm due to the bottled compressed tracer gas. There is currently no approved FSAR representative accident analysis for releases of airborne radioactive material caused by compressed air disturbance.

Facility Worker Safety

Six hazardous conditions were assigned a safety consequence of S1 (facility worker impact) and a frequency of F3 (anticipated). The FSAR requires that S1-F3 hazardous conditions be evaluated for control allocation to ensure that facility worker safety issues are being adequately addressed. The IDs of the hazardous conditions were: PTWSR-03, PTWSR-05, PTWSR-20, PTWSR-25, PTWSR-29, and PTWSR-49-NEW1.

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4.0 ACCIDENT ANALYSIS

Hazardous conditions are determined to be represented by a FSAR representative accident by comparing the material at risk, release characteristics, cause, and accident sequence with the representative accident. The comparison is qualitative in nature. If a hazardous condition cannot be grouped under an existing representative accident, then further analysis is required to determine if a new representative accident scenario needs to be developed or the analysis of an existing representative accident needs to be expanded. Table B10 of Appendix B, presents the S2 and S3 category hazardous conditions grouped by the applicable FSAR representative accident. This table contains the BIN, Item ID, material at risk, hazardous condition, cause, frequency category, safety consequence category, cause group code, and representative accident designator. The table is intended to provide objective evidence of whether a hazardous condition can be represented by an existing representative accident. If a hazardous condition cannot be represented by an existing representative accident, then further accident analysis may need to be developed.

Based on the hazard analysis, there were only two hazardous conditions that were identified that needed to be mapped to a representative accident. Both of these hazardous conditions were for a ruptured air line in a contaminated area. Currently there is not a FSAR representative accident for these hazardous conditions and therefore an accident analysis would normally be developed. In this case however, there is currently an Unreviewed Safety Question (USQ) open for compressed air for which an accident analysis is being performed in support of closing the USQ. Until such time that the USQ can be closed, the U.S. Department of Energy, Office of River Protection (ORP) has limited operations in the tank farms to those activities required to support TSRs, environmental compliance, reducing routine exposure or those that pose low risk. For this activity, measures are being taken to prevent the release of contamination in the event of a compressed air line rupture, as described in Chapter 5, Control Allocation. Special approval from the ORP will need to be obtained for the Oceaneering® DST annulus wall cleaning system operation regarding the risk posed due to compressed gas line ruptures.

Note that there were seven hazardous conditions that had S3 consequences but a frequency of F0, beyond extremely unlikely, which therefore do not require controls and accident consequence analyses is not required.

Mission Impact hazards are not discussed in the accident analysis because they do not contribute to onsite or offsite consequences.

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5.0 CONTROL ALLOCATION

5.1 METHODOLOGY

The control decision/allocation process is described in Section 3.3.1.5 of the FSAR and implemented by the "Control Decision Meetings" procedure found in the CH2M HILL Hanford Group, Inc., HNF-IP-0842, Revision 0, Volume IV, Section 5.4, "Engineering." In accordance with the procedure, the controls were selected based upon the mapping to the representative accidents by a selected group of individuals from the hazards analysis team. Since there were only two hazardous conditions that warranted controls and there was no representative accident for these hazardous conditions (but an open USQ exists), a typical control decision was not performed. Instead the control decision team looked at the operating parameters and system configuration of the Oceaneering® DST annulus wall cleaning system identified compensatory measures that manage risk during the use of the wall cleaning system, as described below.

5.2 ALLOCATED CONTROLS

The control decision/allocation records are presented in Appendix C. Hazardous conditions with estimated S2 or S3 consequences and estimated frequency of occurrence greater than F0 are evaluated for control applicability. Hazardous conditions with S1 consequence and F3 frequency are also evaluated. The tank farm FSAR methodology does not require S0-E0/E1 and S1-F0/F1/F2 hazardous conditions to be evaluated for control applicability and therefore the control entries in the control decision record are left blank. The hazardous conditions are presented by item ID order. A summary of the control allocations grouped by Representative Accident, for S3 (Offsite Individual), S2 (Onsite Worker), and S1-F3 (Facility Worker Safety) is provided in Table 5-1. All hazardous conditions having a safety consequence, regardless of frequency, are included in Appendix C and will be added to the Hazard Analysis Database.

Only two hazardous conditions were identified that met the FSAR criteria for allocation of controls, PTWSR-26 and PTWSR-52-NEW1. Both of these hazardous conditions are for an air line rupture in a contaminated area. There is currently no approved FSAR representative accident analysis for releases of airborne radioactive material caused by an air line rupture. An USQ (TF-01-0331, Rev. 1) was declared by the ORP (Boston, 2001) with respect to a rupture of compressed air systems in contaminated areas. Until the USQ is closed, authorization of operation of compressed air systems is required by the ORP.

The control decision team looked at the operating parameters and system configurations of the compressed air systems for the Oceaneering® DST annulus wall cleaning system. A 150 lb/in² gauge portable air compressor is used to support the wall cleaning system. The portable air compressor is operated at flow rates up to 100 ft³/min at a pressure of 100 lb/in² gauge. Additionally, there is a 300 lb/in² gauge gas bottle that supplies gas to the tank for performing tracer gas studies. The gas supply has an initial regulated charge of approximately 150 lb/in² gauge that is then reduced to approximately 15 lb/in² gauge. Although both compressed air system activities are manned, and operators would be able to be shut down immediately in the case of an air line rupture, the control decision team decided that rubber matting should be

applied under the compressed air lines to prevent the spread of contamination in the case of an air line rupture.

The remaining hazardous conditions, evaluated as part of the control decision process, were related to facility worker safety issues. In all cases the tank farms Safety Management Programs were found to adequately prevent or mitigate the hazards.

Table 5-1. Allocated Controls for Tank 241-A-Y-101 Oceaneering® Wall Cleaning System (S3, S2 and S1-F3 items).
(3 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSCs	Prev TSRs	MIT SSCs	Mit TSRs	Control MEMO	Safety Cat NC	Freq Cat NC	Mission Impact
Hazardous Conditions for Representative Accident 04, Flammable Gas Deflagrations - Double Shell Tank												
PTWSR-04-XNEW1	04X	Tank waste	Release of radioactive and toxic aerosols due to deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler moving)	Reaction of radioactive waste from pre-existing tank failure below waste level with aluminum components of crawler during normal operation generates hydrogen which raises annulus flammable gas concentration above the LFL (spark source assumed present)	None required	None required	None required	None required	No controls required based on low accident frequency.	S3	F0	M3
PTWSR-04-XNEW2	04X	Tank waste	Release of radioactive and toxic aerosols due to deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler stopped)	Reaction of radioactive waste from pre-existing tank leak below waste level with aluminum components of crawler with crawler stopped over leak generates hydrogen raising annulus flammable gas concentration above the LFL (spark source assumed present)	None required	None required	None required	None required	No controls required based on low accident frequency.	S3	F0	M3
PTWSR-18-XNEW1	04X	Tank liquid waste	Release of radioactive and toxic aerosols due to deflagration in annulus caused by ignition of hydrogen created from reaction of waste with crawler aluminum components	Equipment failure or operator error causes crawler to stop, high pressure spray continues to operate, penetration of tank wall below the waste level occurs, waste reacts with aluminum components producing hydrogen (spark assumed present)	None required	None required	None required	None required	No controls required based on low accident frequency.	S3	F0	M3

Table 5-1. Allocated Controls for Tank 241-AY-101 Oceaneering® Wall Cleaning System (S3, S2 and S1-F3 items).
(3 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSCs	Prev TSRs	MIT SSCs	Mit TSRs	Control MEMO	Safety Cat NC	Freq Cat NC	Mission Impact
PTWSR-34	04X	Tank waste	Release of radioactive and hazardous material due to deflagration in the annulus	Crawler system or operations creates spark with flammable gas present in the annulus	None required	None required	None required	None required	No controls required based on low accident frequency.	S3	F0	M3
PTWSR-34-XNEW1	04X	Tank waste	Release of radioactive and hazardous material due to deflagration in the annulus	Crawler falls into pool of waste in annulus resulting in a reaction of the aluminum components of the Crawler system producing sufficient quantities of hydrogen to reach the LFL in the annulus (spark source assumed present)	None required	None required	None required	None required	No controls required based on low accident frequency.	S3	F0	M3
PTWSR-35	04X	Tank waste	Release of radioactive and hazardous material due to deflagration in the primary tank	Crawler system or operations creates spark in the primary tank via a hole in the tank (existing or crawler induced) with flammable gas present in the primary tank	None required	None required	None required	None required	No controls required based on low accident frequency.	S3	F0	M3
PTWSR-40	04X	Tank waste	Release of radioactive and hazardous material due to a deflagration in the annulus	Insertion of crawler into tank annulus results in a spark with flammable gas present	None required	None required	None required	None required	No controls required based on low accident frequency.	S3	F0	M3
Hazardous Conditions Associated With Compressed Gas Disturbance of Contaminated Soil												
PTWSR-26	XX	Contaminated soil	Dispersion of radioactive material due to compressed air line failure above ground lying on contaminated soil	Hose/connection failure, abrasion or cutting by impacted items, human error	Controls will be based on future ORP direction. Actual letter number to be determined and will be entered into the Hazards Database when the ORP transmits the letter authorizing the use of compressed air for Oceaneering® crawler system	---				S2	F3	M0
PTWSR-52-NEW1	XX	Contaminated soil	Dispersion of radioactive material due to compressed gas line failure above ground lying on contaminated soil (tracer gas)	Human error or line failure (assumed very small diameter line)	Controls will be based on future ORP direction. Actual letter number to be determined and will be entered into the Hazards Database when the ORP transmits the letter authorizing the use of compressed air for Oceaneering® crawler system	---				S2	F3	M0

Table 5-1. Allocated Controls for Tank 241-A-Y-101 Oceaneering® Wall Cleaning System (S3, S2 and S1-F3 items).
(3 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSCs	Prev TSRs	MIT SSCs	Mit TSRs	Control MEMO	Safety Cat NC	Freq Cat NC	Mission Impact
Hazardous Conditions Associated With Worker Safety Concerns (S1-F3)												
PTWSR-03		Tank vapor	Release of radioactive and hazardous material (tank vapor) due to an existing hole in the tank. Release is through the annulus ventilation system initially via the crawler vacuum and annulus return system	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	None	None	None	AC 5.24, Safety Management Programs (Radiation Protection and Industrial Hygiene)	Facility worker exposure controlled by AC 5.24, Safety Management Programs.	S1	F3	M1
PTWSR-05		Tank vapor	Release of radioactive and hazardous material (tank vapor) to the above ground crawler vacuum and annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	None	None	None	AC 5.24, Safety Management Programs (Radiation Protection)	Facility worker exposure controlled by AC 5.24, Safety Management Programs.	S1	F3	M1
PTWSR-20		None	Potential facility worker injury as a result of high pressure water line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	None	None	None	AC 5.24, Safety Management Programs (Industrial Safety)	Facility worker safety controlled by AC 5.24, Safety Management Programs.	S1	F3	M0
PTWSR-25		None	Facility worker injury due to compressed air line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	None	None	None	AC 5.24, Safety Management Programs (Industrial Safety)	Facility worker safety controlled by AC 5.24, Safety Management Programs.	S1	F3	M0
PTWSR-29		Collection water tank contents	Release of radioactive and hazardous material to the environment from the collection water tank due to overfilling or leak or failure	Equipment failure, or human error	None	None	None	AC 5.24, Safety Management Programs (Radiation Protection and Industrial Hygiene)	Facility worker exposure controlled by AC 5.24, Safety Management Programs.	S1	F3	M0
PTWSR-49-NEW1		NA	Personnel injury due to contact with high pressure gases	Human error or equipment failure	None	None	None	AC 5.24, Safety Management Programs (Industrial Safety)	Facility worker exposure controlled by AC 5.24, Safety Management Programs.	S1	F3	M0

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6.0 CONCLUSIONS

All hazardous conditions with S3 (offsite individual) potential consequences were evaluated and assigned F0 (beyond extremely unlikely) frequency. No controls are required for hazardous conditions with this frequency category.

There were only two hazardous conditions with S2 (onsite worker) potential consequences. Both of these hazardous conditions were for compressed air. There is currently no FSAR approved representative accident for these hazardous conditions and therefore a USQ was declared by the ORP (Boston, 2001) with respect to rupture of compressed air systems in contaminated areas. Until the USQ is closed, authorization of operation of compressed air systems is by the ORP. A compensatory measure was selected by the control decision team to apply rubber matting under the compressed air lines to prevent the possibility of disturbing any soil contamination in the case of an air line rupture. Authorization from the ORP for use of the compressed air and compressed tracer gas systems will need to be obtained before the crawler is deployed.

The controls to protect the facility worker are those contained in the tank farm Safety Management Programs. These controls were deemed adequate.

The following Mission Impacts controls to reduce the risk of breaching the tank wall from operation of the crawler were evaluated and found to be adequate:

- Requirement for fixed remote camera to be operating to perform wall cleaning,
- “Dead man” control arrangement requiring continuous operator action to maintain high pressure water flow to crawler, and
- Trained and experienced operators provided by the Oceaneering® company for operating the crawler.

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7.0 REFERENCES

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APPENDIX A

PROCESS HAZARDS ANALYSIS TEAM BIOGRAPHICAL INFORMATION

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PROCESS HAZARDS ANALYSIS TEAM BIOGRAPHICAL INFORMATION

Jeffrey E. Andrews (Representing Tank Farm Operations) - B.S. in Chemical Engineering. Operations Representative for hazard evaluation for the Oceaneering Crawler tank wall cleaning system. Fifteen years of operations and engineering experience in the Nuclear Navy and at the Hanford site. Experience at Hanford includes assignments as Shift Manager for tank farms, Tank Farms Final Safety Analysis Report, development and Operations management of several large projects such as C-106 sluicing and AZ-101 mixer pump test.

Jim R. Bellomy III (Representing Maintenance & Reliability Engineering) - Engineer II, Maintenance and Reliability Engineering. Mr. Bellomy has 20 years of engineering experience in design, construction, start-up, testing, and operations support at both commercial and government owned reactor and non-reactor nuclear facilities. He has over 17 years experience at the Hanford Site supporting numerous Hanford construction projects and facility upgrades at N Reactor and the 200 Area tank farms. He has experience in all aspects of systems design, fabrication, construction, testing, and operations and has been involved in several hazard evaluations and safety assessments. Mr. Bellomy has been an Unreviewed Safety Question Evaluator for the past seven years and has provided support to several tank waste retrieval projects including tank 241-C-106 waste retrieval, tank 241-AZ-101 mixer pump testing, long length equipment removal, and saltwell pumping.

David R. Bratzel (Representing Nuclear Safety and Licensing) - B.S. Chemistry; M.S. in Engineering Management. Mr. Bratzel has approximately 23 years of experience at Hanford in the nuclear industry relating to the storage, handling, and transfer of radioactive wastes. Mr. Bratzel has experience in laboratory operations, technology development, and most recently pertaining to resolution of safety issues in the Hanford tanks and nuclear safety analysis to support the tank farm authorization basis.

Stephen R. Chapman (Representing Operations) – Two plus years as a Field Work Supervisor for double-shell tank farms, certified to perform high risk work including tank intrusive work, critical lift crane activities and long length equipment removal and installation. Have recently worked closely with the Tank Integrity and Corrosion Mitigation activities. In the seven years of experience at Hanford I have worked as an operator for single and double shell tank farms, D&D worker at 100N and 233-S as well as a Field Work Supervisor.

Gary Duncan – B.S. Mechanical Engineering; over ten years naval nuclear operations and nine years nuclear operations and project management experience at the Hanford Site. Hanford experience includes shift operation manager, transfer system manager, retrieval operations manager, mixer pump project manager, tank integrity assessment project engineer, and double-shell tanks integrity project manager.

David J. Foust (Representing Radiation Control) – B.S. Physics. 34 years of radiation protection experience, including three years as a licensed reactor operator, eight years as a health physics technician, three years as Radiation Safety Officer at a Uranium mining & milling operation, 12 years as Radiation Protection manager for Hanford Construction and Engineering Contractor and eight years as a Radiological Engineer for various Hanford Contractors.

Lawrence J. Kripps (Representing Nuclear Safety and Licensing) – B.S. and M.S. Nuclear Engineering. Over twenty-nine years experience managing and performing safety analyses and environmental assessments of the U.S. Department of Energy and commercial nuclear and non-nuclear facilities. Provided the initial and continuing technical direction and support in the development of the hazard and accident analyses and controls for the Tank Farms Final Safety Analysis Report and the associated Technical Safety Requirements.

Ruben E. Mendoza (Representing Project Engineering) - B.S. Mechanical Engineering. 12 years of experience includes project management, cost account management, test planning and directing, field work planning and consulting, mechanical design, and stress design/analysis. Has extensive background in equipment testing in Hanford's underground radioactive waste tanks including tank 241-SY-101 hydrogen mitigation mixer pump, flammable gas tank ball rheometer and void fraction meter, and AZ-101 mixer pumps.

William J. Powell (Representing the Design Authority) - BS in Chemical Engineering, Registered Professional Engineer in the State of Montana. Mr. Powell has more than 15 years of experience in the nuclear industry, most of it with the storage, handling and transfer of radioactive waste. He has over 20 years of experience in the chemical and nuclear industry, including Process engineering, accident analysis, Unreviewed Safety Question evaluations and hazard assessments. Other nuclear related experience includes technical evaluation of process conditions and design authority responsibility for major projects on the Hanford site.

Victor Renord - Oceaneering® technical representative with Oceaneering International, Inc. gave a presentation outlining the function and design details of the Oceaneering® crawler. Entertain questions from the team prior to the initiation of the hazard evaluation.

Milton V. Shultz, Jr. ("What If" Facilitator, Nuclear Safety & Licensing) – B.S. Nuclear Engineering Technology. Facilitator for hazard evaluation for the Oceaneering® crawler tank wall cleaning system. More than 27 years experience in a broad range of engineering and technical assignments at the Hanford Site. Experience includes leading Preliminary Hazards Analyses and "What If's" for a variety of tank farms projects, including several for the Tank Farms Final Safety Analysis Report (FSAR), contributor to the hazards analysis work for the FSAR. Has performed independent Nuclear Safety evaluations of reactor plant design and operation at Hanford's N Reactor.

Ryan Smith (Representing Nuclear Safety & Licensing) - B.S. Mechanical Engineering. Six years of experience at the Hanford Site with the last three years specific to Nuclear Safety and Licensing (NS&L) support. NS&L Engineer for the Interim Stabilization, Characterization, and Vados Zone programs. Extensive knowledge in flammable gas related issues related to pumping waste to and from tank farm facilities. Key team member in establishing the authorization basis (AB) for Interim Stabilization and reconciliation of the Los Alamos National Laboratory Safety

Assessment with the Basis of Interim Operations (BIO). Assisted in the transition of the BIO to the FSAR as well as ongoing AB maintenance and clarification support.

Thomas W. Staehr - B.S. Civil Engineering, M.S. Construction Management, Registered Professional Engineer in the State of Washington. More than 25 years of project administration and construction engineering experience in the commercial power and environmental cleanup industries. Hanford experience includes 12 years as a Project Engineer contributing to hazards analysis on various waste retrieval projects including the Grout Disposal Vaults, In Tank Sludge Washing, Tank AZ-101 Waste Retrieval System (Mixer Pumps) and the Initial Waste retrieval System projects.

Gary R. Tardiff (Representing AY & AZ Engineering) - B.S. Chemical Engineering. Mr. Tardiff has been working in East Tank Farms for approximately nine years as the AY and AZ Tank Farms System and Cognizant Engineer and has been supporting many projects such as W-030, W-151, W-211, W-314, W-523, W-525 as well as the Caustic Mitigation project for AY-101 and AY-102. He has worked for 12 year as a process engineering and shift engineer at the PUREX Facility. He has also worked for DuPont (test engineer) and WR Grace (process engineer) before coming to Hanford.

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APPENDIX B

HAZARDS EVALUATION TABLES

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**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-01	Tank Annulus/Scale Removal	Loss of vacuum causes crawler to fall off the wall and damages SSCs located in the annulus	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs	None	Damage to SSCs located in the annulus (e.g.: temperature monitoring system, primary tank leak detection system, four 4" side fill lines, annulus ventilation system air lines, secondary liner)	Tether on crawler Hydraulic support arms	--	S0	F3	M1	No significant radioactive material contamination has been identified in the annulus. M1 based on the potential for damage to annulus SSCs and delay. Hydraulic arm system would significantly reduce likelihood of crawler falling off wall due to vacuum failure.
PTWSR-02	Tank Annulus/Scale Removal	Loss of crawler contact with wall causes it to fall and damages SSCs located in the annulus	Irregular or curved tank surface	None	Damage to SSCs located in the annulus (e.g.: temperature monitoring system, primary tank leak detection system, four 4" side fill lines, annulus ventilation system air lines, secondary liner)	Tether on crawler Hydraulic support arms	--	S0	F3	M1	No significant radioactive material contamination has been identified in the annulus. M1 based on the potential for damage to annulus SSCs and delay. Hydraulic arm system would significantly reduce likelihood of crawler falling off wall due to vacuum failure.
PTWSR-03	Tank Annulus/Scale Removal	Release of radioactive and hazardous material (tank vapor) due to an existing hole in the tank. Release is through the annulus ventilation system initially via the crawler vacuum and annulus return system	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	Tank vapor	Radioactive and hazardous material release	Annulus CAM system Annulus ventilation system including HEPA filter	AC: Safety Program (Radiation Protection, Industrial Hygiene)	S1	F3	M1	The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The F3 frequency is conservative due to current uncertainties with tank integrity. M1 based on contamination of equipment.
PTWSR-04	Tank Annulus/Scale Removal	Release of radioactive and hazardous material (tank liquid waste) due to an existing hole in the tank. Release is through the annulus ventilation system initially via the crawler vacuum and annulus return system	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	Tank liquid waste	Radioactive and hazardous material release Note: Consequences are more severe for tank liquid waste versus tank vapor.	Annulus CAM system Annulus ventilation system including HEPA filter	AC: Safety Program (Radiation Protection, Industrial Hygiene)	S1	F2	M1	Tank waste level is ~70" (~200,000 gal). The crawler above ground support systems are assumed to confine any radioactive and hazardous material. M1 based on contamination of equipment. The frequency of F2 is based on the fact that a pre-existing tank wall failure below the waste level would have been detected by leak detectors or elevated radiation levels in the annulus.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceanengineering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-04-XNEW1	Tank Annulus/Scale Removal	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler moving)	Reaction of radioactive waste from pre-existing tank failure below waste level with aluminum components of crawler during normal operation generates hydrogen which raises annulus flammable gas concentration above the LFL (spark source assumed present)	Tank waste	Radioactive and hazardous material release to atmosphere	--	--	S3	F0	M3	<p>Tank waste level is ~70" (~200,000 gal).</p> <p>The crawler above ground support systems are assumed to confine any radioactive and hazardous material.</p> <p>The total estimated weight of Aluminum in the crawler is 150 lbs.</p> <p>The frequency of F0 is based on:</p> <ol style="list-style-type: none"> 1. The large volume of the annulus (~28,000 cubic feet). 2. The short time the crawler would be located over the pre-existing hole limits the quantity of hydrogen that would be generated from waste being in contact with the crawler aluminum components. 3. Compressed air is exhausted from the crawler drive motors into the vacuum system providing additional dilution of any hydrogen that might be produced (flow estimated at 30 scfm).

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-04-XNEW2	Tank Annulus/Scale Removal	Release of radioactive and toxic aerosols due to deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler stopped)	Reaction of radioactive waste from pre-existing tank leak below waste level with aluminum components of crawler with over leak generates hydrogen raising annulus flammable gas concentration above the LFL. (spark source assumed present)	Tank waste	Radioactive and hazardous material release to atmosphere	--	--	S3	F0	M3	<p>Tank waste level is ~70" (~200,000 gal).</p> <p>The above ground support systems for the crawler are assumed to confine any radioactive and hazardous material.</p> <p>The total estimated weight of Aluminum in the crawler is 150 lbs.</p> <p>F0 frequency based on:</p> <ol style="list-style-type: none"> 1. The location of a pre-existing leak is a random condition. Failure of the crawler causing it to stop over a pre-existing leak is a random event. The combination of these two situations is very unlikely. 2. It is assumed that crawler movement is being continuously monitored from a fixed remote camera and the operator trained and experienced so that any stoppage would be immediately investigated and actions taken to recover the crawler. This would limit the time that waste would be in contact with crawler aluminum components. 3. Not all of the aluminum in the crawler will be exposed to waste from a leak. 4. The likelihood of a common mode event causing vacuum system failure and the crawler to stop over a pre-existing leak is beyond extremely unlikely. 5. Hydrogen produced by waste reaction with aluminum components in the crawler vacuum flow path will be immediately mixed with the annulus atmosphere preventing localized areas of high concentration of hydrogen. 6. The large volume of the annulus (~28,000 cubic feet) would require significant quantities of hydrogen to be generated to reach the LFL. This implies that large quantities of waste would be needed to be drawn into the vacuum system. 7. Waste in the vacuum system would be detected as high radiation from the vacuum system. The system would be shut down and recovery actions started. This would limit the quantity of waste that came into contact with the aluminum components and the duration of the contact.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat	Freq Cat	Mission Impact	REMARKS
PTWSR-05	Tank Annulus/Scale Removal	Release of radioactive and hazardous material (tank vapor) to the above ground crawler vacuum and annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	Tank vapor	Contamination of crawler vacuum and annulus return radiation exposure to facility workers	Annulus CAM system	AC: Safety Program (Radiation Protection) Note: Continuous radiation monitoring is recommended	S1	F3	M1	The crawler above ground support systems are assumed to confine any radioactive and hazardous material. Consequences are limited because of the short time the crawler is positioned over the tank hole. The F3 frequency is conservative due to current uncertainties with tank integrity. M1 based on contamination of equipment.
PTWSR-06	Tank Annulus/Scale Removal	Release of radioactive and hazardous material (tank liquid waste) to the above ground crawler vacuum and annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	Tank liquid waste	Contamination of crawler vacuum and annulus return radiation exposure to facility workers Note: Consequences are more severe for tank liquid waste versus tank vapor.	Annulus CAM system	AC: Safety Program (Radiation Protection) Note: Continuous radiation monitoring is recommended	S1	F2	M1	The crawler above ground support systems are assumed to confine any radioactive and hazardous material. Consequences are limited because of the short time the crawler is positioned over the tank hole. Tank waste level is ~70" (~200,000 gal). M1 based on contamination of equipment.
PTWSR-07	Tank Annulus/Scale Removal	Release of radioactive and hazardous material (existing corrosion scale, concrete splatter, etc. on exterior wall of primary tank) through the annulus ventilation system via the crawler vacuum and annulus return system	Normal operation (vacuum system draws removed material into system piping and equipment)	Corrosion scale, concrete splatter, etc. on exterior wall of primary tank Note: No significant radioactive contamination is expected.	None	Annulus CAM system Annulus ventilation system including HEPA filter	AC: Safety Program (Radiation Protection, Industrial Hygiene)	S0	F3	M0	No significant radioactive material contamination has been identified in the annulus. The crawler above ground support systems are assumed to confine any radioactive and hazardous material.

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ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-08	Tank Annulus/Scale Removal	Inability to detect primary tank leak as a result of water leaked to annulus due to insufficient crawler vacuum	Damaged crawler vacuum seal, irregular or curved surface, low vacuum	None	Water added to annulus makes primary leak detection system incapable of detecting leak and added moisture contributes to corrosion	Primary tank leak detection system Cameras	Operator visual monitoring	S0	F2	M0	Water is supplied by an ultra-high pressure liquid blaster pumping system rated for 6 gpm (22.71 lpm) at 40,000 psig (2800 bar), featuring a pump with 0.660" (15.76 mm) plungers. Dual rupture discs designed to rupture if rated operating pressure of unit is exceeded. Protects pump from overloading, relieves 100% of volume if operating pressure is exceeded. Positive displacement pumps do not materially change flow rate due to operating pressure changes. The F2 frequency is based on the expectation that the crawler would fall off wall first.
PTWSR-09	Tank Annulus/Scale Removal	Inability to detect primary tank leak as a result of water leaked to annulus due to crawler falling off wall and continued high pressure water flow	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs, irregular or curved surface	None	Water added to annulus makes primary leak detection system incapable of detecting leak and added moisture contributes to corrosion	Primary tank leak detection system Cameras Dead man switch Hydraulic support arms	Operator visual monitoring	S0	F3	M0	Water is supplied by an ultra-high pressure liquid blaster pumping system rated for 6 gpm (22.71 lpm) at 40,000 psig (2800 bar), featuring a pump with 0.660" (15.76 mm) plungers. Dual rupture discs designed to rupture if rated operating pressure of unit is exceeded. Protects pump from overloading, relieves 100% of volume if operating pressure is exceeded. Positive displacement pumps do not materially change flow rate due to operating pressure changes. The dead man switch will be attached to the joystick that controls crawler movement. Hydraulic arm system would significantly reduce likelihood of crawler falling off wall due to vacuum failure.
PTWSR-10	Tank Annulus/Scale Removal	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high vacuum preventing crawler movement	Vacuum pump malfunction	None	Tank damage	Crawler design Cameras Dead man switch	Operator visual monitoring	S0	F1	M2	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-AY-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The frequency of F1 is based on the crawler design and operating experience (Oceaneering provided information verifying operating experience). The M2 is based on possible reduction in tank life or required tank repair. The dead man switch will be attached to the joystick that controls crawler movement.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-10-NEW1	Tank Annulus/Scale Removal	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high force from hydraulic arms preventing crawler movement	Malfunction of the hydraulic supply system to the arms	None	Tank damage	Cameras Dead man switch	Operator visual monitoring	S0	F2	M2	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-A-Y-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The frequency of F2 is based on lack of information and performance experience for this design. The M2 is based on possible reduction in tank life or required tank repair. The dead man switch will be attached to the joystick that controls crawler movement.
PTWSR-10-NEW2	Tank Annulus/Scale Removal	Primary tank wall damaged (i.e., thinning of tank wall) as a result of hydraulic arms hanging up on annulus secondary wall preventing crawler movement	Physical obstruction on annulus secondary wall Hydraulic arm rollers freeze up	None	Tank damage	Cameras Dead man switch Hydraulic arms that are retractable	Operator visual monitoring	S0	F2	M2	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-A-Y-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The frequency of F2 is based on the crawler design. The M2 is based on possible reduction in tank life or required tank repair. The dead man switch will be attached to the joystick that controls crawler movement.
PTWSR-10-NEW3	Tank Annulus/Scale Removal	Primary tank wall damaged as a result of hydraulic arms overpressure on annulus secondary wall	Hydraulic system failure causes high pressure	None	Tank damage	- -	Operator visual monitoring	S0	F2	M2	The footprint of the crawler is large enough that tank wall penetration is not expected. Most likely consequence would be deformation of wall if wall can be deformed at all.
PTWSR-10-NEW4	Tank Annulus/Scale Removal	Annulus secondary tank wall damaged as a result of hydraulic arms overpressure on annulus secondary wall	Hydraulic system failure causes high pressure	None	Secondary tank damage	Construction of secondary containment (concrete backed steel liner) Cameras	Operator visual monitoring	S0	F2	M2	The rollers on the arms represent rounded points of contact which result in high unit area forces.

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Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-11	Tank Annulus/Scale Removal	Release of radioactive material and hazardous radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole above the waste	Vacuum pump malfunction	Tank vapor	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers	Crawler design Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	S1	F1	M2	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-A-Y-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The frequency of F1 is based on the crawler design and operating experience (Oceaneering provided information verifying operating experience). The dead man switch will be attached to the joystick that controls crawler movement.
PTWSR-11-NEW1	Tank Annulus/Scale Removal	Release of radioactive material and hazardous radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm malfunction	Tank vapor	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers	Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	S1	F2	M2	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-A-Y-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The frequency of F2 is based on lack of information and performance experience for this design. The M2 is based on possible reduction in tank life or required tank repair. The dead man switch will be attached to the joystick that controls crawler movement.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-12	Tank Annulus/Scale Removal	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole below the waste	Vacuum pump malfunction	Tank liquid waste	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers Note: Consequences are more severe for tank liquid waste versus tank vapor.	Crawler design Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	SI	F1	M3	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-AY-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The frequency of F1 is based on the crawler design and operating experience (Oceaneering provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.
PTWSR-12-NEW1	Tank Annulus/Scale Removal	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm failure	Tank liquid waste	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers Note: Consequences are more severe for tank liquid waste versus tank vapor.	Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	SI	F2	M3	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-AY-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The frequency of F2 is based on crawler design and operating experience (Oceaneering provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.

**Table B1. "What-If" Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-13	Tank Annulus/Scale Removal	Damage to primary tank wall (i.e., thinning of the tank wall) due to crawler stopping with spray nozzles rotating	Equipment failure, crawler impacts annulus structure, or operator error	None	Tank damage	Cameras Dead man switch	Operator visual monitoring	S0	F2	M2	Estimated four hours to cut through 1/2 steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-A-Y-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The M2 is based on possible reduction in tank life or required tank repair. The frequency of F2 is based on crawler design and operating experience (Oceaneering provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.

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Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat	Freq Cat	Mission Impact	REMARKS
PTWSR-14	Tank Annulus/Scale Removal	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole above the waste surface	Equipment failure, crawler impacts annulus structure, or operator error	Tank vapor	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers	Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	S1	F2	M2	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-A-Y-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The frequency of F2 is based on crawler design and operating experience (Oceaneering provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.
PTWSR-15	Tank Annulus/Scale Removal	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole below the waste surface	Equipment failure, crawler impacts annulus structure, or operator error	Tank liquid waste	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers Note: Consequences are more severe for tank liquid waste versus tank vapor.	Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	S1	F2	M3	Estimated four hours to cut through 1/2" steel if crawler stops but spray nozzle rotation continues. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-A-Y-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The frequency of F2 is based on crawler design and operating experience (Oceaneering provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.

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ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-16	Tank Annulus/Scale Removal	Damage to primary tank wall (i.e., thinning of tank wall) due to crawler stopping with spray nozzles not rotating	Equipment failure (e.g., loss of air to crawler), or operator error	None	Tank damage	Cameras Dead man switch	Operator visual monitoring	S0	F2	M2	Estimated 20 minutes to cut through 1/2" steel if crawler and spray nozzle rotation stop. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-AY-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The M2 is based on possible reduction in tank life unless damage is repaired. The frequency of F2 is based on crawler design and operating experience (Oceaneering provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.
PTWSR-17	Tank Annulus/Scale Removal	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole above the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	Tank vapor	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers	Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	S1	F2	M2	Estimated 20 minutes to cut through 1/2" steel if crawler and spray nozzle rotation stop. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-AY-101 is shown on drawing H-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The frequency of F2 is based on crawler design and operating experience (Oceaneering provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.

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ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-18	Tank Annulus/Scale Removal	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole below the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	Tank liquid waste	Radioactive and hazardous material release, contamination of crawler vacuum and annulus return system, and direct radiation exposure to facility workers Note: Consequences are more severe for tank liquid waste versus tank vapor.	Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	S1	F2	M3	Estimated 20 minutes to cut through 1/2" steel if crawler and spray nozzle rotation stop. The relationship for time to penetrate is linear with wall thickness. The primary tank wall thickness for tank 241-AY-101 is shown on drawing IF-2-64449. The bottom knuckle and first 3 feet of the tank is 7/8" thick, it is 3/4" thick for the next 9 feet, 1/2" thick for the next ~20 feet and 3/8" thick (1 1/2 feet above the maximum liquid level) to the top. The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The frequency of F2 is based on crawler design and operating experience (Oceaneering® provided information verifying operating experience). Assumes fixed remote camera operating, operator trained and experienced, and system has a "dead man" control arrangement for the high pressure wash water supply to the crawler. The dead man switch will be attached to the joystick that controls crawler movement.

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ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat	Freq Cat	Mission Impact	REMARKS
PTWSR-18-XNEW1	Tank Annulus/Scale Removal	Release of radioactive and toxic aerosols due to deflagration in annulus caused by ignition of hydrogen created from reaction of waste with crawler aluminum components	Equipment failure or operator error causes crawler to stop, high pressure spray continues to operate, penetration of tank wall below the waste level occurs, waste reacts with aluminum components producing hydrogen (spark assumed present)	Tank liquid waste	Radioactive and hazardous material release to atmosphere	Cameras Dead man switch Annulus CAM Annulus ventilation system including HEPA filter	Operator visual monitoring AC: Safety Program (Radiation Protection, Industrial Hygiene) Note: Continuous radiation monitoring is recommended	S3	F0	M3	The crawler above ground support systems are assumed to confine any radioactive and hazardous material. The total estimated weight of Aluminum in the crawler is 150 lbs. The frequency of F0 is based on the following reasons: 1. Crawler design and operating experience (Oceaneering® provided information verifying operating experience) indicates that cutting through the tank wall is unlikely (F2). The system has a “dead man” control arrangement for the high pressure wash water supply to the crawler. 2. It is assumed that crawler movement is being continuously monitored from a fixed remote camera and the operator is trained and experienced so that any stoppage would be immediately investigated and actions taken to recover the crawler. This would limit the time that waste would be in contact with crawler aluminum components. 3. Not all of the aluminum in the crawler will be exposed to waste from a leak. 4. Hydrogen produced by waste reaction with aluminum components in the crawler vacuum flow path will be immediately mixed with the annulus atmosphere preventing localized areas of high concentration of hydrogen. 5. The large volume of the annulus (~28,000 cubic feet) would require significant quantities of hydrogen to be generated to reach the LFL. This implies that large quantities of waste would need to be drawn into the vacuum system. 6. Waste in the vacuum system would be detected as high radiation from the vacuum system. The system would be shut down and recovery actions started. This would limit the quantity of waste that came into contact with the aluminum components and the duration of the contact.
PTWSR-19	Tank Annulus/Scale Removal	Primary tank wall damaged (i.e., thinning of tank wall) as a result of crawler spray nozzles not rotating, but crawler continues to move	Equipment failure	None	Incomplete corrosion scale removal and potential for some tank damage	Cameras	Operator visual monitoring (i.e., streaks)	S0	F3	M0	It is assumed that as long as the crawler is moving there is only a limited potential for tank damage and no possibility of causing a hole in the tank.

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ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-20	Above Ground/Scale Removal Support System	Potential facility worker injury as a result of high pressure water line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	None	Facility worker injury	Hose and connection design (i.e., standard design features for ultra high pressure lines)	A.C. Safety Management Programs (Industrial Safety)	S1	F3	M0	Positive displacement pump and high pressure hose and connection design limit available energy.
PTWSR-21	Tank Annulus/Scale Removal	Inability to detect primary tank leak as a result of water leaked to annulus due to insufficient crawler vacuum	Hose/connection failure, abrasion or cutting by impacted items, human error	None	Water added to annulus makes primary leak detection system incapable of detecting leak and added moisture contributes to corrosion	Hose/connection design (i.e., standard design features for ultra high pressure lines) Primary tank leak detection system Cameras	Operator visual monitoring	S0	F3	M0	Water is supplied by an ultra-high pressure liquid blaster pumping system rated for 6 gpm (22.7 lpm) at 40,000 psig (2800 bar), featuring a pump with 0.660" (15.76 mm) plungers. Dual rupture discs designed to rupture if rated operating pressure of unit is exceeded. Protects pump from overloading, relieves 100% of volume if operating pressure is exceeded. Positive displacement pumps do not materially change flow rate due to operating pressure changes. Crawler could be operated without vacuum system functioning as the hydraulic arm system would maintain crawler contact with tank wall.
PTWSR-22	Tank Annulus/Scale Removal	Inadequate corrosion scale removal due to loss of water or low pressure water to crawler	Hose/connection leak, high pressure water supply system equipment failure	None	Failure or incomplete corrosion scale removal	Cameras	Operator visual monitoring	S0	F3	M0	--
PTWSR-23	Tank Annulus/Scale Removal	Damage to SSCs located in the annulus as a result of crawler falling off tank wall due to vacuum line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	None	Crawler falls off wall and damages SSCs located in the annulus	Tether on crawler Hydraulic arm system	--	S0	F3	M1	No significant radioactive material contamination has been identified in the annulus. M1 based on the potential for damage to annulus SSCs and delay. Hydraulic arm system would significantly reduce likelihood of crawler falling off wall due to vacuum failure. Umbilical will be configured to have the vacuum tube and pneumatic and water lines around the vacuum tube covered by a plastic spiral wrap.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-24	Tank Annulus/Scale Removal	Damage to SSCs located in the annulus as a result of crawler falling off tank wall due to vacuum line failure in annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	Note	Crawler falls off wall and damages SSCs located in the annulus	Tether on crawler Hydraulic arm system	--	S0	F3	M1	No significant radioactive material contamination has been identified in the annulus. M1 based on the potential for damage to annulus SSCs and delay. Hydraulic arm system would significantly reduce likelihood of crawler falling off wall due to vacuum failure. Umbilical will be configured to have the vacuum tube and pneumatic and water lines around the vacuum tube covered by a plastic spiral wrap.
PTWSR-24-NEW1	Tank Annulus/Scale Removal	Release of hydraulic fluid into tank annulus due to hydraulic line failure or hydraulic cylinder leaks results in potential hydraulic fluid removal issue	Failure of hydraulic lines or hydraulic cylinder leaks	Hydraulic oil (in annulus)	This could be an issue for cleanup or leak detector operation impact.	--	--	S0	F3	M0	Small quantities of oil are not a safety concern in the annulus. Removal and cleanup are operational concerns only. The current design of the umbilical uses a plastic spiral wrap to contain the vacuum line, compressed air lines, hydraulic lines and control signal lines in an easily handled bundle.
PTWSR-24-NEW2	Tank Annulus/Scale Removal	Fire in annulus due to leaked hydraulic oil being ignited	Hydraulic oil leak plus ignition source	Hydraulic oil	Creation of smoke, potential cause of damage to umbilical from heat	--	--	S0	F1	M1	Quantities of hydraulic fluid are limited. Small diameter supply lines and small accumulator. M1 based on potential delay of wall cleaning activities.
PTWSR-25	Above Ground/Scale Removal Support Systems	Facility worker injury due to compressed air line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	None	Facility worker injury Also loss of crawler control and spray nozzle rotation	--	AC: Safety Management Programs (Industrial Safety)	S1	F3	M0	--
PTWSR-26	Above Ground/Scale Removal Support Systems	Dispersion of radioactive material due to compressed air line failure above ground lying on contaminated soil	Hose/connection failure, abrasion or cutting by impacted items, human error	Contaminated soil	Release of airborne radioactive material and facility worker injury Also loss of crawler control and spray nozzle rotation	--	AC: Safety Management Programs (Radiation Protection, Industrial Hygiene and Safety)	S2	F3	M0	There is currently no representative accident analysis for releases of airborne radioactive material caused by compressed air disturbance. A USQ was declared by Boston, 2001) in a letter dated May 14, 2001 (Boston, 2001) with respect to rupture of compressed air systems in contaminated areas. Until the USQ is closed authorization of operation of compressed air systems is on a case by case basis by the ORP. Authorization from the ORP for use of the compressed air system for the crawler will need to be obtained. The current design of the umbilical uses a plastic spiral wrap to contain the vacuum line, compressed air lines, hydraulic lines and control signal lines in an easily handled bundle.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-27	Tank Annulus/Scale Removal	Loss of crawler control and spray nozzle rotation due to compressed air line failure in annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	None	Loss of crawler control and spray nozzle rotation, damage to crawler or SSCs located in the annulus, pressurization of the annulus	Cameras	Operator visual observation	S0	F3	M0	Quantities of hydraulic fluid are limited. Small diameter supply lines and small accumulator. M1 based on potential delay of wall cleaning activities.
PTWSR-28	Tank Annulus/Scale Removal	Loss of visual observation of crawler operation due to crawler camera failure	Equipment failure	None	Loss of close-up view of crawler operations and effectiveness	Cameras are available via risers	Operator visual observations with other camera(s)	S0	F3	M0	Visual observation of crawler movement is considered necessary by at least one camera. (There will be 2 cameras on the crawler and at least one camera in the annulus before cleaning starts).
PTWSR-29	Above Ground/Scale Removal Support Systems	Release of radioactive and hazardous material to the environment from the collection water tank due to overfilling or leak or failure	Equipment failure, or human error	Collection water tank contents	Release to the environment	--	Visual observation AC: Safety Management Program (Radiation Protection, Industrial Hygiene)	S1	F3	M0	The consequences of S1 are conservative since the contents of collection water tank are not expected to be radioactive or hazardous.
PTWSR-30	Tank Annulus/Scale Removal	Temperature monitoring system (thermocouple) wiring in the annulus damaged as a result of crawler movement	Equipment failure, or human error	None	Loss of temperature monitoring	Camera	Operator visual observation	S0	F2	M0	The frequency of F2 is based on the crawler design and operating experience (Oceaneering® provided information verifying operating experience).
PTWSR-31	Tank Annulus/Scale Removal	Primary tank wall damaged due to rotating spray nozzle impacting primary tank or spray nozzle structural failure	Equipment failure, irregular or curved surface	None unless primary tank is penetrated	Tank damage and loss of crawler	--	--	S0	F0	M1	Tank damage by mechanical contact with rotating spray nozzle is not considered credible. Nozzles are fragile and would not damage tank with direct contact. Nozzles would break and then pressure would be reduced because the high pressure water supply is flow limited. Breaking the nozzle would result in increased flow through nozzle.
PTWSR-32	Above Ground/Scale Removal Support System	Releases of airborne and/or liquid radioactive and hazardous material due to loss of above ground crawler vacuum and annulus return system confinement	Equipment failure, vehicle impact, human error	Corrosion scale removed from the tank wall	Airborne and/or liquid releases of radioactive and hazardous material	--	Visual observation	S0	F3	M0	No significant radioactive material contamination has been identified in the annulus.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceaneering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-33	Tank Annulus/Scale Removal	Release of radioactive material (tank vapor or liquid waste) due to a hole in the tank (existing or crawler induced) AND loss of above ground crawler vacuum and annulus return system confinement	Equipment failure, vehicle impact, human error	Tank vapor or tank liquid waste	Airborne and/or liquid releases of radioactive and hazardous material	None required	None required	S1	F0	M1	The frequency is F0 because the two events are independent.
PTWSR-34	Tank Annulus/Scale Removal	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler system or operations creates spark with flammable gas present in the annulus	Tank waste	Primary tank failure and similar consequences to a flammable gas deflagrations in the primary tank	Primary tank leak detection system	LCO: Primary tank leak detection system AC: Transfer controls (material balance)	S3	F0	M3	The frequency of F0 is based on the likelihood of an undetected waste mistransfer or primary tank leak of >12,000 gal into the annulus during crawler operations. The existing SB controls also prevent this postulated accident (annulus leak detection and emergency response to DST leak).
PTWSR-34-XNEW1	Tank Annulus/Scale Removal	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler falls into pool of waste in annulus resulting in a reaction of the aluminum components of the Crawler system producing sufficient quantities of hydrogen to reach the LFL in the annulus (spark source assumed present)	Tank waste	Primary tank failure and similar consequences to a flammable gas deflagrations in the primary tank	Primary tank leak detection system	LCO: Primary tank leak detection system AC: Transfer controls (material balance)	S3	F0	M3	The frequency of F0 is based on the likelihood of an undetected waste mistransfer or primary tank leak sufficiently large to produce a pool of waste in the bottom of the annulus large enough to immerse the crawler. The existing SB controls also prevent this postulated accident (annulus leak detection and emergency response to DST leak) The total estimated weight of Aluminum in the crawler is 150 lbs.
PTWSR-35	Tank Annulus/Scale Removal	Release of radioactive and hazardous material due to flammable gas deflagration in the primary tank	Crawler system or operations creates spark in the primary tank via a hole in the tank (existing or crawler induced) with flammable gas present in the primary tank	Tank waste	Primary tank failure and similar consequences to a flammable gas deflagrations in the primary tank	None required	None required	S3	F0	M3	The frequency of F0 is based on lack of mechanism for crawler to cause spark source inside primary tank and the improbability of primary tank being above the lower flammability limit (LFL) during crawler operation.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceanering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-36	Tank Annulus/Scale Removal	Tank annulus pressurized due to loss of annulus ventilation system during crawler operation	Equipment failure, or human error	None	Positive annulus pressure and the potential for unfiltered releases	--	AC: Safety Management Program (Radiation Protection, Industrial Hygiene)	S0	F3	M0	No significant radioactive material contamination has been identified in the annulus. Compressed air exhausted during crawler operation could contribute to tank pressurization. Note: Compressed air from drive motors is exhausted into the vacuum system.
PTWSR-37	Tank Annulus/Scale Removal	Crawler failure prevents its return to riser for removal	Equipment failure, human error	None	Crawler can not be retrieved from annulus	Tethers and cable management system	--	S0	F3	M1	No safety issue with loss of crawler in the annulus.
PTWSR-38	Installation of above ground support systems (e.g., high pressure water skid, water supply truck, vacuum pump skid, collection water tank, control console, electric power generations systems)	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	Note: To the extent possible support systems will be located outside of the tank farm. Existing controls for potential hazardous conditions typical of these type activities, such as AC 5.16, "Dome Loading Controls," may apply. Current plan is to obtain water from existing supply source outside the farm (fire hydrant).
PTWSR-39	Removal of above ground support systems (e.g., high pressure water skid, water supply truck, vacuum pump skid, collection water tank, control console, electric power generations systems)	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	The collection water tank will be sampled and the contents disposed of in accordance with existing requirements.

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Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-40	Tank annulus - crawler installation and removal	Release of radioactive and hazardous material due to a deflagration in the annulus	Insertion of crawler into tank annulus results in a spark with flammable gas present	Tank waste	Primary tank failure and similar consequences to a flammable gas deflagration in the primary tank	Primary tank leak detection system	LCO: Primary tank leak detection system AC: Transfer controls (material balance)	S3	F0	M3	The frequency of F0 is based on the likelihood of an undetected waste mistransfer or primary tank leak of >12,000 gal into the annulus prior to crawler insertion. The existing SB controls also prevent this postulated accident.
PTWSR-41	Tank annulus - crawler installation and removal	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	Note: Potential hazardous conditions is addressed in previous PTWSR hazardous conditions.
PTWSR-42	Tank annulus - crawler installation and removal	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	--
PTWSR-42-NEW1	Tank annulus - crawler installation and removal	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.	Human error or crane equipment failure	NA	Need to repair riser, potential degradation of annulus confinement integrity	--	Hoisting and Rigging Manual requirements	S0	F3	M1	Repair assumed to be required before issue closed out.
PTWSR-42-NEW2	Tank annulus - crawler installation and removal	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.	Human error	NA	Tank damage and loss of crawler	--	--	S0	F3	M1	Not assumed that significant damage to the riser will occur if crawler hangs up.
PTWSR-43	Tank annulus - crawler installation and removal	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	--

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Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-44	Support Activity - Fueling	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	Assumes no large quantities of fuel inside of tank farm. Diesel or gasoline fuels required for crawler support systems pose no new or unique hazardous conditions. Note: To the extent possible support systems will be located outside of the tank farm.
PTWSR-45	Support System - Electrical Supply	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	Crawler support systems will be modular systems and will generally be outside of the tank farm fence. Electrical systems pose no new or unique hazardous conditions.
PTWSR-46	Support System - Cameras and Lighting	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	Camera and lighting systems pose no new or unique hazardous conditions.
PTWSR-47	General industrial hazards associated with crawler operation	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	Plan is to have two cameras on crawler and two cameras in annulus. One annulus camera operating and the other camera in staged position to facilitate transition from one location to another in the annulus.
PTWSR-48	Natural Phenomena	This ID is used to document that the hazard evaluation team did not identify any unique potential hazardous conditions associated with this activity.			NA			NA	NA	NA	Natural Phenomena hazards (e.g., earthquakes, extreme wind) were not considered significant contributors to potential hazardous conditions during crawler installation, operation, and removal and do not result in new or unique hazardous conditions not already addressed.
PTWSR-49-NEW1	Tracer Gas System	Personnel injury due to contact with high pressure gases	Human error or equipment failure	NA	Personnel injury	--	AC 5.24 Safety Management Programs	S1	F3	M0	Worker safety issue only.
PTWSR-50-NEW1	Tracer Gas System	Personnel injury due to exposure to toxic gasses (tracer gas is non-toxic)	Human error or equipment failure	Gas released as a result of leak detection activity	Personnel injury	--	AC 5.24 Safety Management Programs	S1	F0	M0	Tracer gas is inert and non-toxic - the composition of the gas is proprietary but the supplier has indicated that it is non-toxic.

**Table B1. “What-If” Checklist Hazards Evaluation Data for the Oceanengineering®
Double-Shell Tank Annulus Wall Cleaning System. (21 sheets)**

ID	Location & Activity	Hazardous Condition	Cause	MAR	Consequence(s)	Engineered Safety Features	Administrative Safety Features	Safety Cat NC	Freq Cat NC	Mission Impact	REMARKS
PTWSR-51-NEW/1	Tracer Gas System	Inaccurate results for leak detection due to reaction of tracer gas with tank waste	Intrinsic condition	NA	Failure to detect a leak	--	--	S0	F2	M0	Captured for completeness.
PTWSR-52-NEW/1	Tracer Gas System	Dispersion of radioactive material due to compressed gas line failure above ground lying on contaminated soil (tracer gas)	Human error or line failure (assumed very small diameter line)	Contaminated soil	Movement of contaminated soil in the tank farm	--	AC 5.24 Safety Management Programs	S2	F3	M0	Assumed that the gas will be introduced into tank headspace through primary tank riser. No pits will be involved. The supply line will be small diameter tubing. The bottle will be 300 psig capable, charged to 150 psig with the tracer gas regulated to 15 psig for supply into the waste tank headspace. There is currently no representative accident analysis for releases of airborne radioactive material caused by compressed air disturbance. A USQ was declared in a letter dated May 14, 2001 (Boston, 2001) with respect to rupture of compressed air systems in contaminated areas. Until the USQ is closed authorization of operation of compressed air systems is on a case by case basis by the ORP. Authorization from the ORP for use of the compressed tracer gas system will need to be obtained.

**Table B2. Hazardous Conditions With Potentially Significant Offsite Consequences (S3).
(1 sheet)**

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-04-XNEW1	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler moving)	Reaction of radioactive waste from pre-existing tank failure below waste level with aluminum components of crawler during normal operation generates hydrogen which raises annulus flammable gas concentration above the LFL (spark source assumed present)	F0	E3
PTWSR-04-XNEW2	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler stopped)	Reaction of radioactive waste from pre-existing tank leak below waste level with aluminum components of crawler with crawler stopped over leak generates hydrogen raising annulus flammable gas concentration above the LFL (spark source assumed present)	F0	E3
PTWSR-18-XNEW1	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from reaction of waste with crawler aluminum components	Equipment failure or operator error causes crawler to stop, high pressure spray continues to operate, penetration of tank wall below the waste level occurs, waste reacts with aluminum components producing hydrogen (spark assumed present)	F0	E0
PTWSR-34	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler system or operations creates spark with flammable gas present in the annulus	F0	E3
PTWSR-34-XNEW1	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler falls into pool of waste in annulus resulting in a reaction of the aluminum components of the Crawler system producing sufficient quantities of hydrogen to reach the LFL in the annulus (spark source assumed present)	F0	E3
PTWSR-35	Release of radioactive and hazardous material due to flammable gas deflagration in the primary tank	Crawler system or operations creates spark in the primary tank via a hole in the tank (existing or crawler induced) with flammable gas present in the primary tank	F0	E3
PTWSR-40	Release of radioactive and hazardous material due to a flammable gas deflagration in the annulus	Insertion of crawler into tank annulus results in a spark with flammable gas present	F0	E3

**Table B3. Hazardous Conditions With Potentially Significant Onsite Consequences (S2).
(1 sheet)**

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-26	Dispersion of radioactive material due to compressed air line failure above ground lying on contaminated soil	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E2
PTWSR-52-NEW1	Dispersion of radioactive material due to compressed gas line failure above ground lying on contaminated soil (tracer gas)	Human error or line failure (assumed very small diameter line)	F3	E2

**Table B4. Hazardous Conditions With Potentially Significant Worker Consequences (S1).
(2 sheets)**

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-03	Release of radioactive and hazardous material (tank vapor) due to an existing hole in the tank. Release is through the annulus ventilation system initially via the crawler vacuum and annulus return system	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	F3	E1
PTWSR-04	Release of radioactive and hazardous material (tank liquid waste) due to an existing hole in the tank. Release is through the annulus ventilation system initially via the crawler vacuum and annulus return system	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	F2	E1
PTWSR-05	Release of radioactive and hazardous material (tank vapor) to the above ground crawler vacuum and annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	F3	E1
PTWSR-06	Release of radioactive and hazardous material (tank liquid waste) to the above ground crawler vacuum and annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	F2	E1
PTWSR-11	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole above the waste	Vacuum pump malfunction	F1	E1
PTWSR-11-NEW1	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm malfunction	F2	E1
PTWSR-12	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole below the waste	Vacuum pump malfunction	F1	E1
PTWSR-12-NEW1	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm failure	F2	E1
PTWSR-14	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole above the waste surface	Equipment failure, crawler impacts annulus structure, or operator error	F2	E1
PTWSR-15	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole below the waste surface	Equipment failure, crawler impacts annulus structure, or operator error	F2	E1
PTWSR-17	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole above the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	F2	E1

**Table B4. Hazardous Conditions With Potentially Significant Worker Consequences (S1).
(2 sheets)**

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-18	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole below the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	F2	E0
PTWSR-20	Potential facility worker injury as a result of high pressure water line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-25	Facility worker injury due to compressed air line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-29	Release of radioactive and hazardous material to the environment from the collection water tank due to overfilling or leak or failure	Equipment failure, or human error	F3	E1
PTWSR-33	Release of radioactive and hazardous material (tank vapor or liquid waste) due to a hole in the tank (existing or crawler induced) AND loss of above ground crawler vacuum and annulus return system confinement	Equipment failure, vehicle impact, human error	F0	E1
PTWSR-49-NEW1	Personnel injury due to contact with high pressure gases	Human error or equipment failure	F3	E0
PTWSR-50-NEW1	Personnel injury due to exposure to toxic gasses (tracer gas is non toxic)	Human error or equipment failure	F0	E0

Table B5. Hazardous Conditions With No Significant Consequences (S0). (2 sheets)

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-01	Loss of vacuum causes crawler to fall off the wall and damages SSCs located in the annulus	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs	F3	E0
PTWSR-02	Loss of crawler contact with wall causes it to fall and damages SSCs located in the annulus	Irregular or curved tank surface	F3	E0
PTWSR-07	Release of radioactive and hazardous material (existing corrosion scale, concrete splatter, etc. on exterior wall of primary tank) through the annulus ventilation system via the crawler vacuum and annulus return system	Normal operation (vacuum system draws removed material into system piping and equipment)	F3	E0
PTWSR-08	Inability to detect primary tank leak as a result of water leaked to annulus due to insufficient crawler vacuum	Damaged crawler vacuum seal, irregular or curved surface, low vacuum	F2	E0
PTWSR-09	Inability to detect primary tank leak as a result of water leaked to annulus due to crawler falling off wall and continued high pressure water flow	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs, irregular or curved surface	F3	E0
PTWSR-10	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high vacuum preventing crawler movement	Vacuum pump malfunction	F1	E0
PTWSR-10-NEW1	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high force from hydraulic arms preventing crawler movement	Malfunction of the hydraulic supply system to the arms	F2	E0
PTWSR-10-NEW2	Primary tank wall damaged (i.e., thinning of tank wall) as a result of hydraulic arms hanging up on annulus secondary wall preventing crawler movement	Physical obstruction on annulus secondary wall Hydraulic arm rollers freeze up	F2	E0
PTWSR-10-NEW3	Primary tank wall damaged as a result of hydraulic arms overpressure on annulus secondary wall	Hydraulic system failure causes high pressure	F2	E0
PTWSR-10-NEW4	Annulus secondary tank wall damaged as a result of hydraulic arms overpressure on annulus secondary wall	Hydraulic system failure causes high pressure	F2	E0
PTWSR-13	Damage to primary tank wall (i.e., thinning of the tank wall) due to crawler stopping with spray nozzles rotating	Equipment failure, crawler impacts annulus structure, or operator error	F2	E0
PTWSR-16	Damage to primary tank wall (i.e., thinning of tank wall) due to crawler stopping with spray nozzles not rotating	Equipment failure (e.g., loss of air to crawler), or operator error	F2	E0
PTWSR-19	Primary tank wall damaged (i.e., thinning of tank wall) as a result of crawler spray nozzles not rotating, but crawler continues to move	Equipment failure	F3	E0
PTWSR-21	Inability to detect primary tank leak as a result of water leaked to annulus due to insufficient crawler vacuum	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-22	Inadequate corrosion scale removal due to loss of water or low pressure water to crawler	Hose/connection leak, high pressure water supply system equipment failure	F3	E0
PTWSR-23	Damage to SSCs located in the annulus as a result of crawler falling off tank wall due to vacuum line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-24	Damage to SSCs located in the annulus as a result of crawler falling off tank wall due to vacuum line failure in annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-24-NEW1	Release of hydraulic fluid into tank annulus due to hydraulic line failure or hydraulic cylinder leaks results in potential hydraulic fluid removal issue	Failure of hydraulic lines or hydraulic cylinder leaks	F3	E0
PTWSR-24-NEW2	Fire in annulus due to leaked hydraulic oil being ignited	Hydraulic oil leak plus ignition source	F1	E0

Table B5. Hazardous Conditions With No Significant Consequences (S0). (2 sheets)

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-27	Loss of crawler control and spray nozzle rotation due to compressed air line failure in annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-28	Loss of visual observation of crawler operation due to crawler camera failure	Equipment failure	F3	E0
PTWSR-30	Temperature monitoring system (thermocouple) wiring in the annulus damaged as a result of crawler movement	Equipment failure, or human error	F2	E0
PTWSR-31	Primary tank wall damaged due to rotating spray nozzle impacting primary tank or spray nozzle structural failure	Equipment failure, irregular or curved surface	F0	E0
PTWSR-32	Releases of airborne and/or liquid radioactive and hazardous material due to loss of above ground crawler vacuum and annulus return system confinement	Equipment failure, vehicle impact, human error	F3	E0
PTWSR-36	Tank annulus pressurized due to loss of annulus ventilation system during crawler operation	Equipment failure, or human error	F3	E0
PTWSR-37	Crawler failure prevents its return to riser for removal	Equipment failure, human error	F3	E0
PTWSR-42-NEW1	Damage to tank annulus riser due to installation of "A" frame riser tether hoisting system (crane load drop)	Human error or crane equipment failure	F3	E0
PTWSR-42-NEW2	Crawler dropped as a result of hang up on riser during removal (using "A" frame hoisting equipment)	Human error	F3	E0
PTWSR-51-NEW1	Inaccurate results for leak detection due to reaction of tracer gas with tank waste	Intrinsic condition	F2	E0

Table B6. Hazardous Conditions Having Serious Potential Mission Impact (M3) (1 sheet)

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-04-XNEW1	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler moving)	Reaction of radioactive waste from pre-existing tank failure below waste level with aluminum components of crawler during normal operation generates hydrogen which raises annulus flammable gas concentration above the LFL (spark source assumed present)	F0	E3
PTWSR-04-XNEW2	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler stopped)	Reaction of radioactive waste from pre-existing tank leak below waste level with aluminum components of crawler with crawler stopped over leak generates hydrogen raising annulus flammable gas concentration above the LFL (spark source assumed present)	F0	E3
PTWSR-12	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole below the waste	Vacuum pump malfunction	F1	E1
PTWSR-12-NEW1	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm failure	F2	E1
PTWSR-15	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole below the waste surface	Equipment failure, crawler impacts annulus structure, or operator error	F2	E1
PTWSR-18	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole below the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	F2	E0
PTWSR-18-XNEW1	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from reaction of waste with crawler aluminum components	Equipment failure or operator error causes crawler to stop, high pressure spray continues to operate, penetration of tank wall below the waste level occurs, waste reacts with aluminum components producing hydrogen (spark assumed present)	F0	E0
PTWSR-34	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler system or operations creates spark with flammable gas present in the annulus	F0	E3
PTWSR-34-XNEW1	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler falls into pool of waste in annulus resulting in a reaction of the aluminum components of the Crawler system producing sufficient quantities of hydrogen to reach the LFL in the annulus (spark source assumed present)	F0	E3
PTWSR-35	Release of radioactive and hazardous material due to flammable gas deflagration in the primary tank	Crawler system or operations creates spark in the primary tank via a hole in the tank (existing or crawler induced) with flammable gas present in the primary tank	F0	E3
PTWSR-40	Release of radioactive and hazardous material due to a flammable gas deflagration in the annulus	Insertion of crawler into tank annulus results in a spark with flammable gas present	F0	E3

Table B7. Hazardous Conditions Having Moderate Potential Mission Impact (M2)
(1 sheet)

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-10	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high vacuum preventing crawler movement	Vacuum pump malfunction	F1	E0
PTWSR-10-NEW1	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high force from hydraulic arms preventing crawler movement	Malfunction of the hydraulic supply system to the arms	F2	E0
PTWSR-10-NEW2	Primary tank wall damaged (i.e., thinning of tank wall) as a result of hydraulic arms hanging up on annulus secondary wall preventing crawler movement	Physical obstruction on annulus secondary wall Hydraulic arm rollers freeze up	F2	E0
PTWSR-10-NEW3	Primary tank wall damaged as a result of hydraulic arms overpressure on annulus secondary wall	Hydraulic system failure causes high pressure	F2	E0
PTWSR-10-NEW4	Annulus secondary tank wall damaged as a result of hydraulic arms overpressure on annulus secondary wall	Hydraulic system failure causes high pressure	F2	E0
PTWSR-11	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole above the waste	Vacuum pump malfunction	F1	E1
PTWSR-11-NEW1	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm malfunction	F2	E1
PTWSR-13	Damage to primary tank wall (i.e., thinning of the tank wall) due to crawler stopping with spray nozzles rotating	Equipment failure, crawler impacts annulus structure, or operator error	F2	E0
PTWSR-14	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole above the waste surface	Equipment failure, crawler impacts annulus structure, or operator error	F2	E1
PTWSR-16	Damage to primary tank wall (i.e., thinning of tank wall) due to crawler stopping with spray nozzles not rotating	Equipment failure (e.g., loss of air to crawler), or operator error	F2	E0
PTWSR-17	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole above the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	F2	E1

Table B8. Hazardous Conditions Having Minor Potential Mission Impact (M1) (1 sheet)

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-01	Loss of vacuum causes crawler to fall off the wall and damages SSCs located in the annulus	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs	F3	E0
PTWSR-02	Loss of crawler contact with wall causes it to fall and damages SSCs located in the annulus	Irregular or curved tank surface	F3	E0
PTWSR-03	Release of radioactive and hazardous material (tank vapor) due to an existing hole in the tank. Release is through the annulus ventilation system initially via the crawler vacuum and annulus return system	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	F3	E1
PTWSR-04	Release of radioactive and hazardous material (tank liquid waste) due to an existing hole in the tank. Release is through the annulus ventilation system initially via the crawler vacuum and annulus return system	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	F2	E1
PTWSR-05	Release of radioactive and hazardous material (tank vapor) to the above ground crawler vacuum and annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	F3	E1
PTWSR-06	Release of radioactive and hazardous material (tank liquid waste) to the above ground crawler vacuum and annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	F2	E1
PTWSR-23	Damage to SSCs located in the annulus as a result of crawler falling off tank wall due to vacuum line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-24	Damage to SSCs located in the annulus as a result of crawler falling off tank wall due to vacuum line failure in annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-24-NEW2	Fire in annulus due to leaked hydraulic oil being ignited	Hydraulic oil leak plus ignition source	F1	E0
PTWSR-31	Primary tank wall damaged due to rotating spray nozzle impacting primary tank or spray nozzle structural failure	Equipment failure, irregular or curved surface	F0	E0
PTWSR-33	Release of radioactive and hazardous material (tank vapor or liquid waste) due to a hole in the tank (existing or crawler induced) AND loss of above ground crawler vacuum and annulus return system confinement	Equipment failure, vehicle impact, human error	F0	E1
PTWSR-37	Crawler failure prevents its return to riser for removal	Equipment failure, human error	F3	E0
PTWSR-42-NEW1	Damage to tank annulus riser due to installation of "A" frame riser tether hoisting system (crane load drop)	Human error or crane equipment failure	F3	E0
PTWSR-42-NEW2	Crawler dropped as a result of hang up on riser during removal (using "A" frame hoisting equipment)	Human error	F3	E0

Table B9. Hazardous Conditions Having Negligible Potential Mission Impact (M0)
(1 sheet)

ID	Hazardous Condition	Cause	Freq Cat NC	Env Cons
PTWSR-07	Release of radioactive and hazardous material (existing corrosion scale, concrete splatter, etc. on exterior wall of primary tank) through the annulus ventilation system via the crawler vacuum and annulus return system	Normal operation (vacuum system draws removed material into system piping and equipment)	F3	E0
PTWSR-08	Inability to detect primary tank leak as a result of water leaked to annulus due to insufficient crawler vacuum	Damaged crawler vacuum seal, irregular or curved surface, low vacuum	F2	E0
PTWSR-09	Inability to detect primary tank leak as a result of water leaked to annulus due to crawler falling off wall and continued high pressure water flow	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs, irregular or curved surface	F3	E0
PTWSR-19	Primary tank wall damaged (i.e., thinning of tank wall) as a result of crawler spray nozzles not rotating, but crawler continues to move	Equipment failure	F3	E0
PTWSR-20	Potential facility worker injury as a result of high pressure water line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-21	Inability to detect primary tank leak as a result of water leaked to annulus due to insufficient crawler vacuum	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-22	Inadequate corrosion scale removal due to loss of water or low pressure water to crawler	Hose/connection leak, high pressure water supply system equipment failure	F3	E0
PTWSR-24-NEW1	Release of hydraulic fluid into tank annulus due to hydraulic line failure or hydraulic cylinder leaks results in potential hydraulic fluid removal issue	Failure of hydraulic lines or hydraulic cylinder leaks	F3	E0
PTWSR-25	Facility worker injury due to compressed air line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-26	Dispersion of radioactive material due to compressed air line failure above ground lying on contaminated soil	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E2
PTWSR-27	Loss of crawler control and spray nozzle rotation due to compressed air line failure in annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	E0
PTWSR-28	Loss of visual observation of crawler operation due to crawler camera failure	Equipment failure	F3	E0
PTWSR-29	Release of radioactive and hazardous material to the environment from the collection water tank due to overfilling or leak or failure	Equipment failure, or human error	F3	E1
PTWSR-30	Temperature monitoring system (thermocouple) wiring in the annulus damaged as a result of crawler movement	Equipment failure, or human error	F2	E0
PTWSR-32	Releases of airborne and/or liquid radioactive and hazardous material due to loss of above ground crawler vacuum and annulus return system confinement	Equipment failure, vehicle impact, human error	F3	E0
PTWSR-36	Tank annulus pressurized due to loss of annulus ventilation system during crawler operation	Equipment failure, or human error	F3	E0
PTWSR-49-NEW1	Personnel injury due to contact with high pressure gases	Human error or equipment failure	F3	E0
PTWSR-50-NEW1	Personnel injury due to exposure to toxic gasses (tracer gas is non toxic)	Human error or equipment failure	F0	E0
PTWSR-51-NEW1	Inaccurate results for leak detection due to reaction of tracer gas with tank waste	Intrinsic condition	F2	E0
PTWSR-52-NEW1	Dispersion of radioactive material due to compressed gas line failure above ground lying on contaminated soil (tracer gas)	Human error or line failure (assumed very small diameter line)	F3	E2

**Table B10. S2 and S3 Hazardous Conditions Grouped by the
Tank Farms Final Safety Analysis Report Representative Accident. (1 sheet)**

BIN	ID	MAR	Hazardous Condition	Cause	Freq Cat NC	Safety Cat NC	Cause Grp	Rep Acc
Representative Accident 04 - Flammable Gas Deflagrations - DST								
A-1-a	PTWSR-04-XNEW1	Tank waste	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler moving)	Reaction of radioactive waste from pre-existing tank failure below waste level with aluminum components of crawler during normal operation generates hydrogen which raises annulus flammable gas concentration above the LFL (spark source assumed present)	F0	S3	B08	04X
A-1-a	PTWSR-04-XNEW2	Tank waste	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler stopped)	Reaction of radioactive waste from pre-existing tank leak below waste level with aluminum components of crawler with crawler stopped over leak generates hydrogen raising annulus flammable gas concentration above the LFL (spark source assumed present)	F0	S3	B08	04X
A-1-a	PTWSR-18-XNEW1	Tank liquid waste	Release of radioactive and toxic aerosols due to flammable gas deflagration in annulus caused by ignition of hydrogen created from reaction of waste with crawler aluminum components	Equipment failure or operator error causes crawler to stop, high pressure spray continues to operate, penetration of tank wall below the waste level occurs, waste reacts with aluminum components producing hydrogen (spark assumed present)	F0	S3	B08	04X
A-1-a	PTWSR-34	Tank waste	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler system or operations creates spark with flammable gas present in the annulus	F0	S3	B08	04X
A-1-a	PTWSR-34-XNEW1	Tank waste	Release of radioactive and hazardous material due to flammable gas deflagration in the annulus	Crawler falls into pool of waste in annulus resulting in a reaction of the aluminum components of the Crawler system producing sufficient quantities of hydrogen to reach the LFL in the annulus (spark source assumed present)	F0	S3	B08	04X
A-1-a	PTWSR-35	Tank waste	Release of radioactive and hazardous material due to flammable gas deflagration in the primary tank	Crawler system or operations creates spark in the primary tank via a hole in the tank (existing or crawler induced) with flammable gas present in the primary tank	F0	S3	B08	04X
A-1-a	PTWSR-40	Tank waste	Release of radioactive and hazardous material due to a flammable gas deflagration in the annulus	Insertion of crawler into tank annulus results in a spark with flammable gas present	F0	S3	B08	04X
Dispersal of Contaminated Soil By Compressed Gas or Air - No Existing Representative Accident								
B-1-a	PTWSR-26	Contaminated soil	Dispersion of radioactive material due to compressed air line failure above ground lying on contaminated soil	Hose/connection failure, abrasion or cutting by impacted items, human error	F3	S2	---	XX
B-1-a	PTWSR-52-NEW1	Contaminated soil	Dispersion of radioactive material due to compressed gas line failure above ground lying on contaminated soil (tracer gas)	Human error or line failure (assumed very small diameter line)	F3	S2	---	XX

APPENDIX C

CONTROL DECISION RECORD

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CONTROL DECISION MEETING ROSTER:

October 9, 2001

<u>Name</u>	<u>Organization</u>	<u>Phone</u>	<u>MSN</u>
Lawrence J. Kripps	NS&L	376-1061	R1-44
Milton V. Shultz	NS&L	372-3740	R1-44
Ryan D. Smith	NS&L	372-1383	R1-49

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Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-01	Loss of vacuum causes crawler to fall off the wall and damages SSCs located in the Annulus	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-02	Loss of crawler contact with wall causes it to fall and damages SSCs located in the Annulus	Irregular or curved tank surface	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-03	Release of radioactive and hazardous material (tank vapor) due to an existing hole in the tank. Release is through the Annulus ventilation system initially via the crawler vacuum and Annulus return system	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	S1	F3	E1	RP/IH

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
AC 5.24 Safety Management Programs (Radiation Protection and Industrial Hygiene)	The programs listed in AC 5.24 are implicitly assumed to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions. The listed programs reduce the likelihood and potential impacts of events, and are covered by their respective regulatory and contractual system of basic requirements.	This AC includes commitments to maintain safety management programs as part of the Tank Farm Contractor safety management systems per U.S. Department of Energy Directive (see Section 5.5.4.24.2 of FSAR).

Preventive TSR

Control	Safety Function	Comments
None	---	---

Control Memo: Facility worker exposure controlled by AC 5.24, Safety Management Programs.**Revision to Original "WHAT IF":** Removed "space aerosols" from MAR to more accurately reflect material at risk.**Material At Risk:** Tank vapor**Remarks:** The controls for this hazardous condition rely on the Radiation Protection and Industrial Hygiene Programs providing monitoring to limit facility worker exposure. Verification of this is indicated by signature of cognizant management on the EDT under which this Safety Evaluation is issued.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-04	Release of radioactive and hazardous material (tank liquid waste) due to an existing hole in the tank. Release is through the Annulus ventilation system initially via the crawler vacuum and Annulus return system	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	S1	F2	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA**Revision to Original "WHAT IF": None****Material At Risk: Tank liquid waste****Remarks: None**

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-04-XNEW1	Release of radioactive and toxic aerosols due to flammable gas deflagration in Annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler moving)	Reaction of radioactive waste from pre-existing tank failure below waste level with aluminum components of crawler during normal operation generates hydrogen which raises Annulus flammable gas concentration above the LFL (spark source assumed present)	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
None required	---	---

Preventive TSR

Control	Safety Function	Comments
None required	---	---

Control Memo: No controls required based on low accident frequency.

Revision to Original "WHAT IF": Additional information was obtained on 10/9/01 and 10/10/01 so a third meeting was held (mini-"WHAT IF") to address the issue of aluminum components in the crawler. Hazardous condition added as a result of that meeting.

Material At Risk: Tank waste**Remarks:** Tank waste level is ~70" (~200,000 gal).

The frequency of F0 is based on:

1. The large volume of the Annulus (~28,000 cubic feet).
2. The short time the crawler would be located over the pre-existing hole limits the quantity of hydrogen that would be generated from waste being in contact with the crawler aluminum components.

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-04-XNEW2	Release of radioactive and toxic aerosols due to flammable gas deflagration in Annulus caused by ignition of hydrogen created from a reaction of waste with crawler aluminum components due to an existing hole in the tank below waste level (crawler stopped)	Reaction of radioactive waste from pre-existing tank leak below waste level with aluminum components of crawler with crawler stopped over leak generates hydrogen raising Annulus flammable gas concentration above the LFL (spark source assumed present)	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
None required	---	---

Preventive TSR

Control	Safety Function	Comments
None required	---	---

Control Memo: No controls required based on low accident frequency.

Revision to Original "WHAT IF": Additional information was obtained on 10/9/01 and 10/10/01 so a third meeting was held (mini-"WHAT IF") to address the issue of aluminum components in the crawler. Hazardous condition added as a result of that meeting.

Material At Risk: Tank waste

Remarks: F0 frequency based on:

1. The location of a pre-existing leak is a random condition. Failure of the crawler causing it to stop over a pre-existing leak is a random event. The combination of these two situations is very unlikely.
2. It is assumed that crawler movement is being continuously monitored from a fixed remote camera and the operator trained and experienced so that any stoppage would be immediately investigated and actions taken to recover the crawler. This would limit the time that waste would be in contact with crawler aluminum components.
3. Not all of the aluminum in the crawler will be exposed to waste from a leak.
4. The likelihood of a common mode event causing vacuum system failure and the crawler to stop over a pre-existing leak is beyond extremely unlikely.
5. Hydrogen produced by waste reaction with aluminum components in the crawler vacuum flow path will be immediately mixed with the Annulus atmosphere preventing localized areas of high concentration of hydrogen.
6. The large volume of the Annulus (~28,000 cubic feet) would require significant quantities of hydrogen to be generated to reach the LFL. This implies that large quantities of waste would need to be drawn into the vacuum system.
7. Waste in the vacuum system would be detected as high radiation from the vacuum system. The system would be shut down and recovery actions started. This would limit the quantity of waste that came into contact with the aluminum components and the duration of the contact.

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-05	Release of radioactive and hazardous material (tank vapor) to the above ground crawler vacuum and Annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler above tank waste level with pre-existing tank failure (vacuum system draws tank atmosphere into system piping and equipment)	S1	F3	E1	RP

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
AC 5.24 Safety Management Programs (Radiation Protection)	The programs listed in AC 5.24 are implicitly assumed to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions. The listed programs reduce the likelihood and potential impacts of events, and are covered by their respective regulatory and contractual system of basic requirements.	This AC includes commitments to maintain safety management programs as part of the Tank Farm Contractor safety management systems per U.S. Department of Energy Directive (see Section 5.5.4.24.2 of FSAR).

Preventive TSR

Control	Safety Function	Comments
None	---	---

Control Memo: Facility worker exposure controlled by AC 5.24, Safety Management Programs.**Revision to Original "WHAT IF":** Removed "space aerosols" from MAR to more accurately reflect material at risk.**Material At Risk:** Tank vapor**Remarks:** The controls for this hazardous condition rely on the Radiation Protection Program providing monitoring to limit facility worker exposure. Verification of this is indicated by signature of cognizant management on the EDT under which this Safety Evaluation is issued.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-06	Release of radioactive and hazardous material (tank liquid waste) to the above ground crawler vacuum and Annulus return system resulting in direct radiation exposure to facility workers	Normal operation of crawler below tank waste level with pre-existing tank failure (vacuum system draws tank waste into system piping and equipment)	S1	F2	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** Tank liquid waste**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-07	Release of radioactive and hazardous material (existing corrosion scale, concrete splatter, etc. on exterior wall of primary tank) through the Annulus ventilation system via the crawler vacuum and Annulus return system	Normal operation (vacuum system draws removed material into system piping and equipment)	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** Corrosion scale, concrete splatter, etc. on exterior wall of primary tank

Note: No significant radioactive contamination is expected.

Remarks: None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-08	Inability to detect primary tank leak as a result of water leaked to Annulus due to insufficient crawler vacuum	Damaged crawler vacuum seal, irregular or curved surface, low vacuum	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-09	Inability to detect primary tank leak as a result of water leaked to Annulus due to crawler falling off wall and continued high pressure water flow	Vacuum pump failure, vacuum hose or connection leak, vacuum hose plugs, irregular or curved surface	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF": None****Material At Risk: None****Remarks: None**

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-10	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high vacuum preventing crawler movement	Vacuum pump malfunction	S0	F1	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-10-NEW1	Primary tank wall damaged (i.e., thinning of tank wall) as a result of high force from hydraulic arms preventing crawler movement	Malfunction of the hydraulic supply system to the arms	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original “WHAT IF”: Hazardous condition added as a result of supplemental “WHAT IF” meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial “WHAT IF” meeting.

Material At Risk: None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-10-NEW2	Primary tank wall damaged (i.e., thinning of tank wall) as a result of hydraulic arms hanging up on Annulus secondary wall preventing crawler movement	Physical obstruction on Annulus secondary wall Hydraulic arm rollers freeze up	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original "WHAT IF": Hazardous condition added as a result of supplemental "WHAT IF" meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial "WHAT IF" meeting.

Material At Risk: None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-10-NEW3	Primary tank wall damaged as a result of hydraulic arms overpressure on Annulus secondary wall	Hydraulic system failure causes high pressure	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original “WHAT IF”: Hazardous condition added as a result of supplemental “WHAT IF” meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial “WHAT IF” meeting.

Material At Risk: None**Remarks: None**

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-10-NEW4	Annulus secondary tank wall damaged as a result of hydraulic arms overpressure on Annulus secondary wall	Hydraulic system failure causes high pressure	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original “WHAT IF”: Hazardous condition added as a result of supplemental “WHAT IF” meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial “WHAT IF” meeting.

Material At Risk: None**Remarks: None**

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-11	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole above the waste	Vacuum pump malfunction	S1	F1	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** Removed "space aerosols" from MAR to more accurately reflect material at risk.**Material At Risk:** Tank vapor**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-11-NEW1	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm malfunction	S1	F2	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original “WHAT IF”: Hazardous condition added as a result of supplemental “WHAT IF” meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial “WHAT IF” meeting.

Material At Risk: Tank vapor**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-12	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high vacuum preventing crawler movement which results in a tank hole below the waste	Vacuum pump malfunction	S1	F1	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** Tank liquid waste**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-12-NEW1	Release of radioactive and hazardous material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of high hydraulic arm pressure preventing crawler movement which results in a tank hole	Hydraulic arm failure	S1	F2	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original “WHAT IF”: Hazardous condition added as a result of supplemental “WHAT IF” meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial “WHAT IF” meeting.

Material At Risk: Tank liquid waste**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-13	Damage to primary tank wall (i.e., thinning of the tank wall) due to crawler stopping with spray nozzles rotating	Equipment failure, crawler impacts Annulus structure, or operator error	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-14	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole above the waste surface	Equipment failure, crawler impacts Annulus structure, or operator error	S1	F2	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** Removed "space aerosols" from MAR to more accurately reflect material at risk.**Material At Risk:** Tank vapor**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-15	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping with spray nozzles rotating creating a tank hole below the waste surface	Equipment failure, crawler impacts Annulus structure, or operator error	S1	F2	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** Tank liquid waste**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-16	Damage to primary tank wall (i.e., thinning of tank wall) due to crawler stopping with spray nozzles not rotating	Equipment failure (e.g., loss of air to crawler), or operator error	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-17	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole above the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	S1	F2	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF":** Removed "space aerosols" from MAR to more accurately reflect material at risk.**Material At Risk:** Tank vapor**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-18	Release of rad and haz material and direct radiation exposure to facility workers from contamination of above ground crawler support systems as a result of crawler stopping and spray nozzles not rotating creating a tank hole below the waste surface	Equipment failure (e.g., loss of air to crawler), or operator error	S1	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** Tank liquid waste**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-18-XNEW1	Release of radioactive and toxic aerosols due to flammable gas deflagration in Annulus caused by ignition of hydrogen created from reaction of waste with crawler aluminum components	Equipment failure or operator error causes crawler to stop, high pressure spray continues to operate, penetration of tank wall below the waste level occurs, waste reacts with aluminum components producing hydrogen (spark assumed present)	S3	F0	E0	04X

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
None required	---	---

Preventive TSR

Control	Safety Function	Comments
None required	---	---

Control Memo: No controls required based on low accident frequency.

Revision to Original "WHAT IF": Additional information was obtained on 10/9/01 and 10/10/01 so a third meeting was held (mini-"WHAT IF") to address the issue of aluminum components in the crawler. Hazardous condition added as a result of that meeting.

Material At Risk: Tank liquid waste

Remarks: The frequency of F0 is based on the following reasons:

1. Crawler design and operating experience (Oceaneering provided information verifying operating experience) indicates that cutting through the tank wall is unlikely (F2). It is assumed that the system has a "dead man" control arrangement for the high pressure wash water supply to the crawler.
2. It is assumed that crawler movement is being continuously monitored from a fixed remote camera and the operator is trained and experienced so that any stoppage would be immediately investigated and actions taken to recover the crawler. This would limit the time that waste would be in contact with crawler aluminum components.
3. Not all of the aluminum in the crawler will be exposed to waste from a leak.
4. Hydrogen produced by waste reaction with aluminum components in the crawler vacuum flow path will be immediately mixed with the Annulus atmosphere preventing localized areas of high concentration of hydrogen.
5. The large volume of the Annulus (~28,000 cubic feet) would require significant quantities of hydrogen to be generated to reach the LFL. This implies that large quantities of waste would need to be drawn into the vacuum system.
6. Waste in the vacuum system would be detected as high radiation from the vacuum system. The system would be shut down and recovery actions started. This would limit the quantity of waste that came into contact with the aluminum components and the duration of the contact.

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-19	Primary tank wall damaged (i.e., thinning of tank wall) as a result of crawler spray nozzles not rotating, but crawler continues to move	Equipment failure	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original "WHAT IF": None****Material At Risk: None****Remarks: None**

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-20	Potential facility worker injury as a result of high pressure water line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	S1	F3	E0	OCC

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
AC 5.24 Safety Management Programs (Industrial Safety)	The programs listed in AC 5.24 are implicitly assumed to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions. The listed programs reduce the likelihood and potential impacts of events, and are covered by their respective regulatory and contractual system of basic requirements.	This AC includes commitments to maintain safety management programs as part of the Tank Farm Contractor safety management systems per U.S. Department of Energy Directive (see Section 5.5.4.24.2 of FSAR).

Preventive TSR

Control	Safety Function	Comments
None	---	---

Control Memo: Facility worker safety controlled by AC 5.24, Safety Management Programs.

Revision to Original "WHAT IF": Changed Env Cons from E1 to E0 to correctly match facility worker injury consequence. Discrepancy discovered during control decision meeting 10/4/01.

Material At Risk: None

Remarks: The controls for this hazardous condition rely on the Industrial Safety Program providing monitoring to limit facility worker exposure. Verification of this is indicated by signature of cognizant management on the EDT under which this Safety Evaluation is issued.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-21	Inability to detect primary tank leak as a result of water leaked to Annulus due to insufficient crawler vacuum	Hose/connection failure, abrasion or cutting by impacted items, human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-22	Inadequate corrosion scale removal due to loss of water or low pressure water to crawler	Hose/connection leak, high pressure water supply system equipment failure	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-23	Damage to SSCs located in the Annulus as a result of crawler falling off tank wall due to vacuum line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-24	Damage to SSCs located in the Annulus as a result of crawler falling off tank wall due to vacuum line failure in Annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-24-NEW1	Release of hydraulic fluid into tank Annulus due to hydraulic line failure or hydraulic cylinder leaks results in potential hydraulic fluid removal issue	Failure of hydraulic lines or hydraulic cylinder leaks	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original “WHAT IF”: Hazardous condition added as a result of supplemental “WHAT IF” meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial “WHAT IF” meeting.

Material At Risk: Hydraulic oil (in Annulus)**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-24-NEW2	Fire in Annulus due to leaked hydraulic oil being ignited	Hydraulic oil leak plus ignition source	S0	F1	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA

Revision to Original “WHAT IF”: Hazardous condition added as a result of supplemental “WHAT IF” meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial “WHAT IF” meeting.

Material At Risk: Hydraulic oil**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-25	Facility worker injury due to compressed air line failure above ground	Hose/connection failure, abrasion or cutting by impacted items, human error	S1	F3	E0	OCC

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
AC 5.24 Safety Management Programs (Industrial Safety)	The programs listed in AC 5.24 are implicitly assumed to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions. The listed programs reduce the likelihood and potential impacts of events, and are covered by their respective regulatory and contractual system of basic requirements.	This AC includes commitments to maintain safety management programs as part of the Tank Farm Contractor safety management systems per U.S. Department of Energy Directive (see Section 5.5.4.24.2 of FSAR).

Preventive TSR

Control	Safety Function	Comments
None	---	---

Control Memo: Facility worker safety controlled by AC 5.24, Safety Management Programs.**Revision to Original "WHAT IF":** Changed Env Cons from E1 to E0 to correctly match the consequence of facility worker injury. Discrepancy discovered during control decision meeting 10/4/01.**Material At Risk:** None**Remarks:** The controls for this hazardous condition rely on the Industrial Safety Program providing monitoring to limit facility worker exposure. Verification of this is indicated by signature of cognizant management on the EDT under which this Safety Evaluation is issued.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-26	Dispersion of radioactive material due to compressed air line failure above ground lying on contaminated soil	Hose/connection failure, abrasion or cutting by impacted items, human error	S2	F3	E2	XX

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: Controls will be based on future ORP direction. Actual letter number to be determined and will be entered into the Hazards Database when the ORP transmits the letter authorizing the use of compressed air for Oceaneering® crawler system.

Revision to Original "WHAT IF": Changed S1 to S2 and E1 to E2 based on uncertainty of soil contamination levels as a result of control decision meeting.

Material At Risk: Contaminated soil

Remarks: There is currently no representative accident analysis for releases of airborne radioactive material caused by compressed air disturbance. A USQ was declared by the ORP in a letter dated May 14, 2001 (Boston, 2001) with respect to rupture of compressed air systems in contaminated areas. Until the USQ is closed authorization of operation of compressed air systems is on a case by case basis by the ORP. Authorization from the ORP for use of the compressed air system for the crawler will need to be obtained.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-27	Loss of crawler control and spray nozzle rotation due to compressed air line failure in Annulus	Hose/connection failure, abrasion or cutting by impacted items, human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-28	Loss of visual observation of crawler operation due to crawler camera failure	Equipment failure	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-29	Release of radioactive and hazardous material to the environment from the collection water tank due to overfilling or leak or failure	Equipment failure, or human error	S1	F3	E1	RP/OC

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
AC 5.24 Safety Management Programs (Radiation Protection and Industrial Hygiene)	The programs listed in AC 5.24 are implicitly assumed to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions. The listed programs reduce the likelihood and potential impacts of events, and are covered by their respective regulatory and contractual system of basic requirements.	This AC includes commitments to maintain safety management programs as part of the Tank Farm Contractor safety management systems per U.S. Department of Energy Directive (see Section 5.5.4.24.2 of FSAR).

Preventive TSR

Control	Safety Function	Comments
None	---	---

Control Memo: Facility worker exposure controlled by AC 5.24, Safety Management Programs.**Revision to Original "WHAT IF":** None**Material At Risk:** Collection water tank contents

Remarks: The controls for this hazardous condition rely on the Radiation Protection and Industrial Hygiene Programs providing monitoring to limit facility worker exposure. Verification of this is indicated by signature of cognizant management on the EDT under which this Safety Evaluation is issued.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-30	Temperature monitoring system (thermocouple) wiring in the Annulus damaged as a result of crawler movement	Equipment failure, or human error	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”: None****Material At Risk: None****Remarks: None**

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-31	Primary tank wall damaged due to rotating spray nozzle impacting primary tank or spray nozzle structural failure	Equipment failure, irregular or curved surface	S0	F0	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** None unless primary tank is penetrated**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-32	Releases of airborne and/or liquid radioactive and hazardous material due to loss of above ground crawler vacuum and Annulus return system confinement	Equipment failure, vehicle impact, human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** Corrosion scale removed from the tank wall**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-33	Release of radioactive and hazardous material (tank vapor or liquid waste) due to a hole in the tank (existing or crawler induced) AND loss of above ground crawler vacuum and Annulus return system confinement	Equipment failure, vehicle impact, human error	S1	F0	E1	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
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Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
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Control Memo: NA**Revision to Original “WHAT IF”:** None**Material At Risk:** Tank vapor or tank liquid waste**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-34	Release of radioactive and hazardous material due to flammable gas deflagration in the Annulus	Crawler system or operations creates spark with flammable gas present in the Annulus	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
None required	---	---

Preventive TSR

Control	Safety Function	Comments
None required	---	---

Control Memo: No controls required based on low accident frequency.**Revision to Original "WHAT IF":** Changed S2 to S3 and E2 to E3 based on FSAR general discussion regarding uncertainty of consequence calculations.**Material At Risk:** Tank waste**Remarks:** The frequency of F0 is based on the likelihood of an undetected waste mistransfer or primary tank leak of >65,000 gal into the Annulus during crawler operations. The existing SB controls also prevent this postulated accident.

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-34-XNEW1	Release of radioactive and hazardous material due to flammable gas deflagration in the Annulus	Crawler falls into pool of waste in Annulus resulting in a reaction of the aluminum components of the Crawler system producing sufficient quantities of hydrogen to reach the LFL in the Annulus (spark source assumed present)	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
None required	---	---

Preventive TSR

Control	Safety Function	Comments
None required	---	---

Control Memo: No controls required based on low accident frequency.

Revision to Original "WHAT IF": Additional information was obtained on 10/9/01 and 10/10/01 so a third meeting was held (mini-"WHAT IF") to address the issue of aluminum components in the crawler. Hazardous condition added as a result of that meeting.

Material At Risk: Tank waste

Remarks: The frequency of F0 is based on the likelihood of an undetected waste mistransfer or primary tank leak sufficiently large to produce a pool of waste in the bottom of the Annulus large enough to immerse the crawler. The existing SB controls also prevent this postulated accident.

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-35	Release of radioactive and hazardous material due to flammable gas deflagration in the primary tank	Crawler system or operations creates spark in the primary tank via a hole in the tank (existing or crawler induced) with flammable gas present in the primary tank	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
None required	---	---

Preventive TSR

Control	Safety Function	Comments
None required	---	---

Control Memo: No controls required based on low accident frequency.**Revision to Original "WHAT IF":** Changed S2 to S3 and E2 to E3 based on FSAR general discussion regarding uncertainty of consequence calculations.**Material At Risk:** Tank waste**Remarks:** The frequency of F0 is based on lack of mechanism for crawler to cause spark source inside primary tank and the improbability of primary tank being above the lower flammability limit (LFL) during crawler operation.

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-36	Tank Annulus pressurized due to loss of Annulus ventilation system during crawler operation	Equipment failure, or human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-37	Crawler failure prevents its return to riser for removal	Equipment failure, human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
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Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
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Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA**Revision to Original "WHAT IF":** None**Material At Risk:** None**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-40	Release of radioactive and hazardous material due to a flammable gas deflagration in the Annulus	Insertion of crawler into tank Annulus results in a spark with flammable gas present	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None required	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
None required	---	---

Preventive TSR

Control	Safety Function	Comments
None required	---	---

Control Memo: No controls required based on low accident frequency.**Revision to Original "WHAT IF":** Changed S2 to S3 and E2 to E3 based on FSAR general discussion regarding uncertainty of consequence calculations.**Material At Risk:** Tank waste**Remarks:** The frequency of F0 is based on the likelihood of an undetected waste mistransfer or primary tank leak of >65,000 gal into the Annulus prior to crawler insertion. The existing SB controls also prevent this postulated accident.

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity: Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus**

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-42-NEW1	Damage to tank Annulus riser due to installation of "A" frame riser tether hoisting system (crane load drop)	Human error or crane equipment failure	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA

Revision to Original "WHAT IF": Hazardous condition added as a result of supplemental "WHAT IF" meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial "WHAT IF" meeting.

Material At Risk: NA**Remarks: None**

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-42-NEW2	Crawler dropped as a result of hang up on riser during removal (using "A" frame hoisting equipment)	Human error	S0	F3	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA

Revision to Original "WHAT IF": Hazardous condition added as a result of supplemental "WHAT IF" meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial "WHAT IF" meeting.

Material At Risk: NA**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-49-NEW1	Personnel injury due to contact with high pressure gases	Human error or equipment failure	S1	F3	E0	OCC

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
None	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
AC 5.24 Safety Management Programs (Industrial Safety)	The programs listed in AC 5.24 are implicitly assumed to minimize risks to the public, onsite workers, and facility workers during normal, abnormal, and emergency conditions. The listed programs reduce the likelihood and potential impacts of events, and are covered by their respective regulatory and contractual system of basic requirements.	This AC includes commitments to maintain safety management programs as part of the Tank Farm Contractor safety management systems per U.S. Department of Energy Directive (see Section 5.5.4.24.2 of FSAR).

Preventive TSR

Control	Safety Function	Comments
None	---	---

Control Memo: Facility worker exposure controlled by AC 5.24, Safety Management Programs.**Revision to Original "WHAT IF":** Hazardous condition added as a result of supplemental "WHAT IF" meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial "WHAT IF" meeting.**Material At Risk:** NA**Remarks:** The controls for this hazardous condition rely on the Industrial Safety Program providing monitoring to limit facility worker exposure. Verification of this is indicated by signature of cognizant management on the EDT under which this Safety Evaluation is issued.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-50-NEW1	Personnel injury due to exposure to toxic gasses (tracer gas is toxic)	Human error or equipment failure	S1	F0	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: NA

Revision to Original "WHAT IF": Hazardous condition added as a result of supplemental "WHAT IF" meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial "WHAT IF" meeting.

Material At Risk: Gas released as a result of leak detection activity**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-51-NEW1	Inaccurate results for leak detection due to reaction of tracer gas with tank waste	Intrinsic condition	S0	F2	E0	---

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments

Preventive TSR

Control	Safety Function	Comments

Control Memo: NA

Revision to Original "WHAT IF": Hazardous condition added as a result of supplemental "WHAT IF" meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial "WHAT IF" meeting.

Material At Risk: NA**Remarks:** None

Note: FSAR requires no controls for hazardous conditions with frequency category of F0; safety consequence and environmental consequence combinations of S0-E0 or S0-E1; or consequence and frequency combinations of S0-F1, S0-F2, S0-F3, S1-F1 or S1-F2.

Control Decision Record**Activity:** Hazard Evaluation for Use of Oceaneering® Crawler System in Tank 241-AY-101 Annulus

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
PTWSR-52-NEW1	Dispersion of radioactive material due to compressed gas line failure above ground lying on contaminated soil (tracer gas)	Human error or line failure (assumed very small diameter line)	S2	F3	E2	XX

Structures, Systems, and Components (SSCs)**Mitigative SSCs**

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Preventive SSCs

SSC	Classification		Safety Function	Comments
	SS	SC		
---	---	---	---	---

Technical Safety Requirements (TSRs)**Mitigative TSR**

Control	Safety Function	Comments
---	---	---

Preventive TSR

Control	Safety Function	Comments
---	---	---

Control Memo: Controls will be based on future ORP direction. Actual letter number to be determined and will be entered into the Hazards Database when the ORP transmits the letter authorizing the use of compressed air for Oceaneering® crawler system

Revision to Original "WHAT IF": Hazardous condition added as a result of supplemental "WHAT IF" meeting on September 25, 2001 that evaluated changes in design that had occurred since the initial "WHAT IF" meeting. Changed S1 to S2 and E1 to E2 based on uncertainty of soil contamination levels as a result of control decision meeting discussion. Changed hazardous condition statement to be similar to PTWSR-26.

Material At Risk: Contaminated soil

Remarks: There is currently no representative accident analysis for releases of airborne radioactive material caused by compressed air disturbance. A USQ was declared by the ORP in a letter dated May 14, 2001 (Boston, 2001) with respect to rupture of compressed air systems in contaminated areas. Until the USQ is closed authorization of operation of compressed air systems is on a case by case basis by the ORP. Authorization from the ORP for use of the compressed tracer gas system will need to be obtained.

APPENDIX D

**TABLE OF CHANGES MADE TO
THE “WHAT IF” DATA**

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CHANGES TO "WHAT IF" DATA

Changes to the "What If" data developed as a result of meetings subsequent to the initial May 29, 2001 meeting or during the hazard identification/evaluation team meetings are summarized in the following table:

Table D1. Summary of "What If" Changes.

ID	Description of Change
• PTWSR-03	Removed "space aerosols" from MAR to more accurately reflect material at risk.
• PTWSR-04-XNEW1	Hazardous condition added as a result new information regarding presence of aluminum components on the crawler.
• PTWSR-04-XNEW2	Hazardous condition added as a result new information regarding presence of aluminum components on the crawler.
• PTWSR-05	Removed "space aerosols" from MAR to more accurately reflect material at risk.
• PTWSR-10-NEW1	Hazardous condition added as a result of supplemental "What If" meeting that evaluated changes in design that had occurred since the initial "What If" meeting.
• PTWSR-10-NEW2	Hazardous condition added as a result of supplemental "What If" meeting that evaluated changes in design that had occurred since the initial "What If" meeting.
• PTWSR-10-NEW3	Hazardous condition added as a result of supplemental "What If" meeting that evaluated changes in design that had occurred since the initial "What If" meeting.
• PTWSR-10-NEW4	Hazardous condition added as a result of supplemental "What If" meeting that evaluated changes in design that had occurred since the initial "What If" meeting.
• PTWSR-11	Hazardous condition added as a result of supplemental "What If" meeting that evaluated changes in design that had occurred since the initial "What If" meeting. Removed "space aerosols" from MAR to more accurately reflect material at risk.
• PTWSR-11-NEW1	Removed "space aerosols" from MAR to more accurately reflect material at risk.
• PTWSR-12-NEW1	Hazardous condition added as a result of supplemental "What If" meeting that evaluated changes in design that had occurred since the initial "What If" meeting.
• PTWSR-14	Removed "space aerosols" from MAR to more accurately reflect material at risk.
• PTWSR-17	Removed "space aerosols" from MAR to more accurately reflect material at risk.
• PTWSR-18-XNEW1	Hazardous condition added as a result new information regarding presence of aluminum components on the crawler.
• PTWSR-20	Changed Env Cons from E1 to E0 to correctly match facility worker injury consequence.
• PTWSR-21-NEW1	Hazardous condition added as a result of supplemental "What If" meeting that evaluated changes in design that had occurred since the initial "What If" meeting.

Table D1. Summary of “What If” Changes.

ID	Description of Change
• PTWSR-21-NEW2	Hazardous condition added as a result of supplemental “What If” meeting that evaluated changes in design that had occurred since the initial “What If” meeting.
• PTWSR-25	Changed Env Cons from E1 to E0 to correctly match facility worker injury consequence.
• PTWSR-26	Changed S1 to S2 and E1 to E2 based on uncertainty of soil contamination levels.
• PTWSR-34	Changed S2 to S3 and E2 to E3 based on FSAR general discussion regarding uncertainty of consequence calculations.
• PTWSR-34-XNEW1	Hazardous condition added as a result new information regarding presence of aluminum components on the crawler.
• PTWSR-35	Changed S2 to S3 and E2 to E3 based on FSAR general discussion regarding uncertainty of consequence calculations.
• PTWSR-40	Changed S2 to S3 and E2 to E3 based on FSAR general discussion regarding uncertainty of consequence calculations.
• PTWSR-42-NEW1	Hazardous condition added as a result of supplemental “What If” meeting that evaluated changes in design that had occurred since the initial “What If” meeting.
• PTWSR-42-NEW2	Hazardous condition added as a result of supplemental “What If” meeting that evaluated changes in design that had occurred since the initial “What If” meeting.
• PTWSR-49-NEW1	Hazardous condition added as a result of supplemental “What If” meeting that evaluated changes in design that had occurred since the initial “What If” meeting.
• PTWSR-50-NEW1	Hazardous condition added as a result of supplemental “What If” meeting that evaluated changes in design that had occurred since the initial “What If” meeting.
• PTWSR-51-NEW1	Hazardous condition added as a result of supplemental “What If” meeting that evaluated changes in design that had occurred since the initial “What If” meeting.
• PTWSR-52-NEW1	Changed S1 to S2 and E1 to E2 based on uncertainty of soil contamination levels as a result of control decision meeting discussion. Changed hazardous condition statement to be similar to PTWSR-26.

APPENDIX E

PEER REVIEW CHECKLIST

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CHECKLIST FOR HAZARD ANALYSIS TECHNICAL PEER REVIEW

Document and Section Reviewed: RPP-8566, Revision 0, "Safety Evaluation for the Oceaneering® Double-Shell Tank Annulus Wall Cleaning System"

Scope of Review: The review is limited to the conduct, content, and technical accuracy of the Safety Evaluation as documented in RPP-8566, Revision 0. A part of this review is to assure that the identified hazards are consistent with previously identified hazardous conditions as described in HNF-SD-WM-TI-764, "Hazard Analysis Database Report."

Yes No NA

- | | | | |
|-------------------------------------|--------------------------|-------------------------------------|--|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The system being evaluated is completely defined. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Methods for identification of hazardous conditions are clearly stated. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The biographical information (education, experience, and technical qualifications) of the hazard identification team is included. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Necessary assumptions are explicitly stated and supported. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Analytical information is appropriate and has been peer reviewed for correctness and accuracy. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | New hazardous conditions (not contained in the Hazard Analysis Database) are identified by unique ID numbers. |
| <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Revised hazardous conditions (currently contained in the Hazard Analysis Database) are clearly identified with revisions shown and documented. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The format, content, and spelling of the information for new or revised hazardous conditions are consistent with current database practice. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | New hazardous conditions are consistent with the analyzed accident to which they are designated. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Blank entries in the tables (database record fields) are verified to be intentional. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Table entries (database record fields) contain data as intended (i.e., normally blank entries do not contain data). |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The control decision process is clearly stated and in accordance with control the control allocation procedure, HNF-IP-0842, 2000, <i>Tank Farms Administration</i> , "Control Decision Meetings," Volume IV, Section 5.4. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | The Control Decision Meeting Attendance Roster is completed and included. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Control allocations are documented in the Control Decision Record. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Information in the hazard tables and Control Decision Record are consistent. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Control allocations are consistent with the representative accident. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Control allocations are consistent with the hazardous condition. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Revised or new controls are clearly identified with reference to where the bases for the control may be found. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Conclusions are consistent with hazard analysis and control decision/allocation results. |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | Concurrence |


 Reviewer (Printed Name and Signature)

10/17/01
 Date

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